

Climate Change in New Hampshire: Floods & Droughts on the Horizon

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Josephine A. Lamprey Professor, Climate & Sustainability

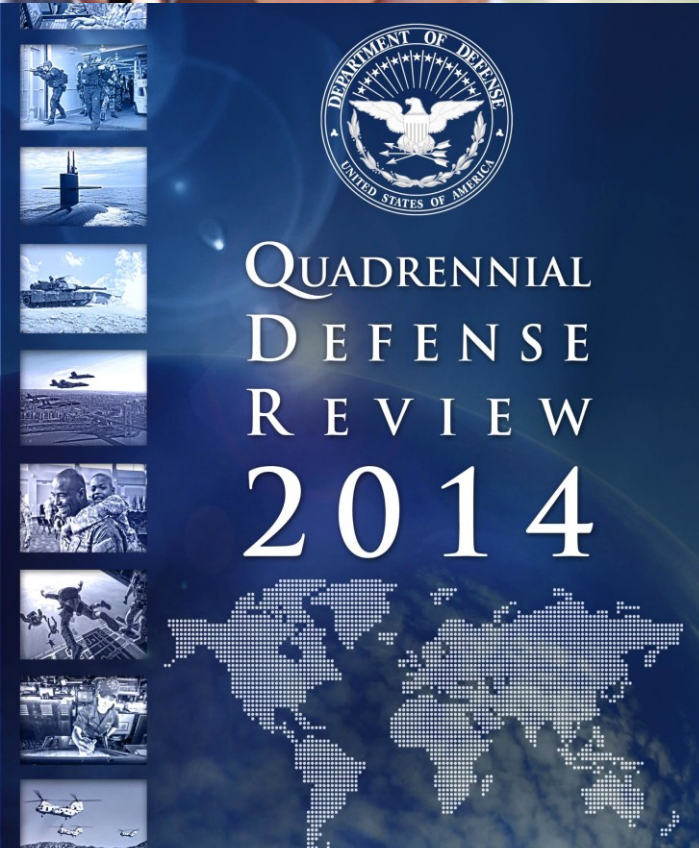
University of New Hampshire



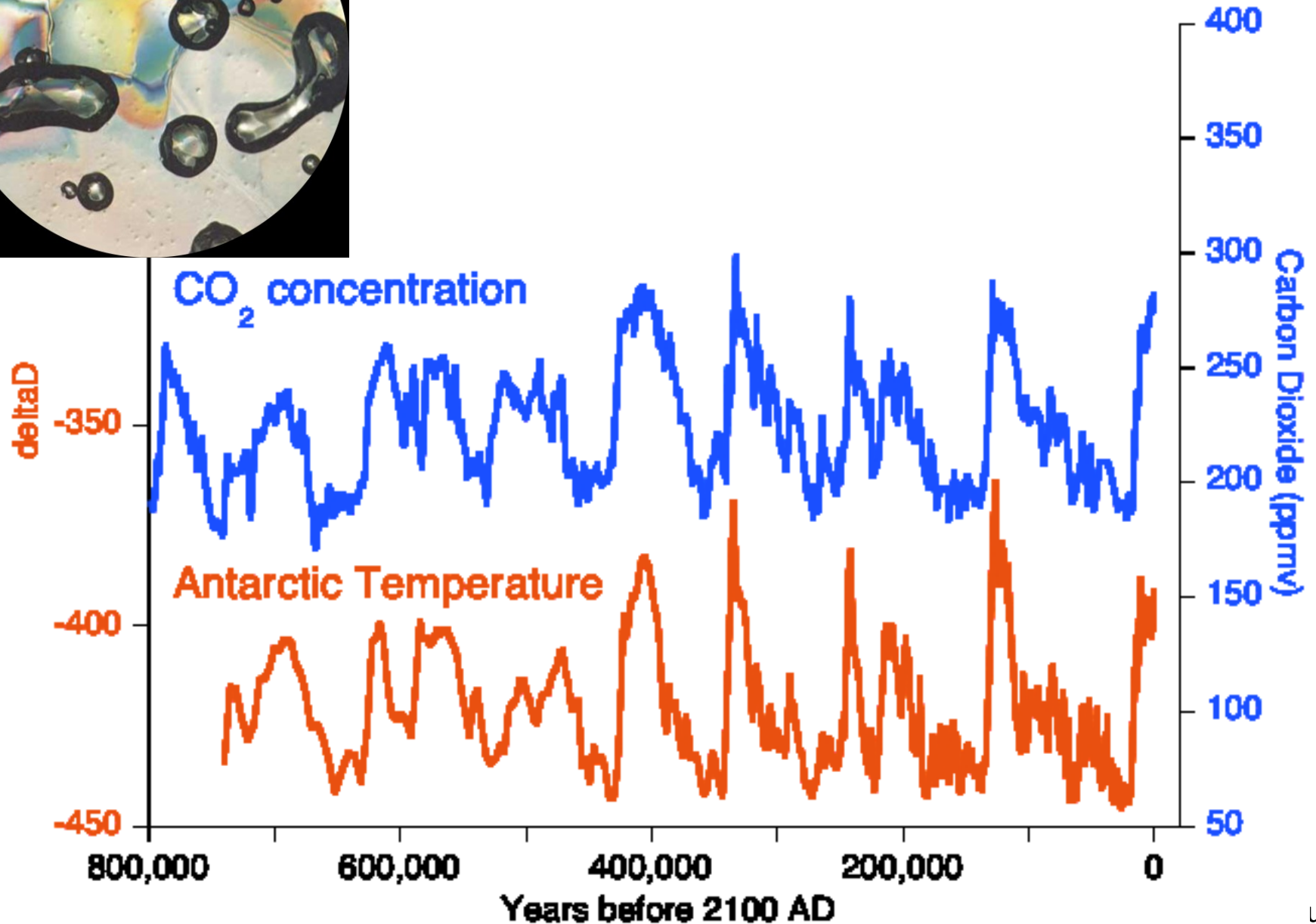
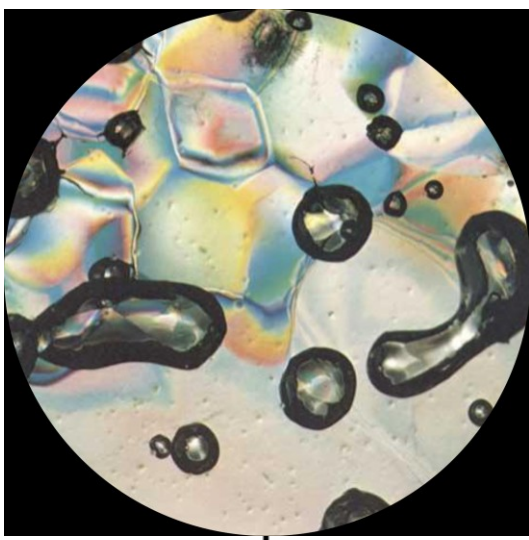
@TheClimateDr

NH DES Drinking Water Source Protection Conference, 11 May 2016, Concord, NH

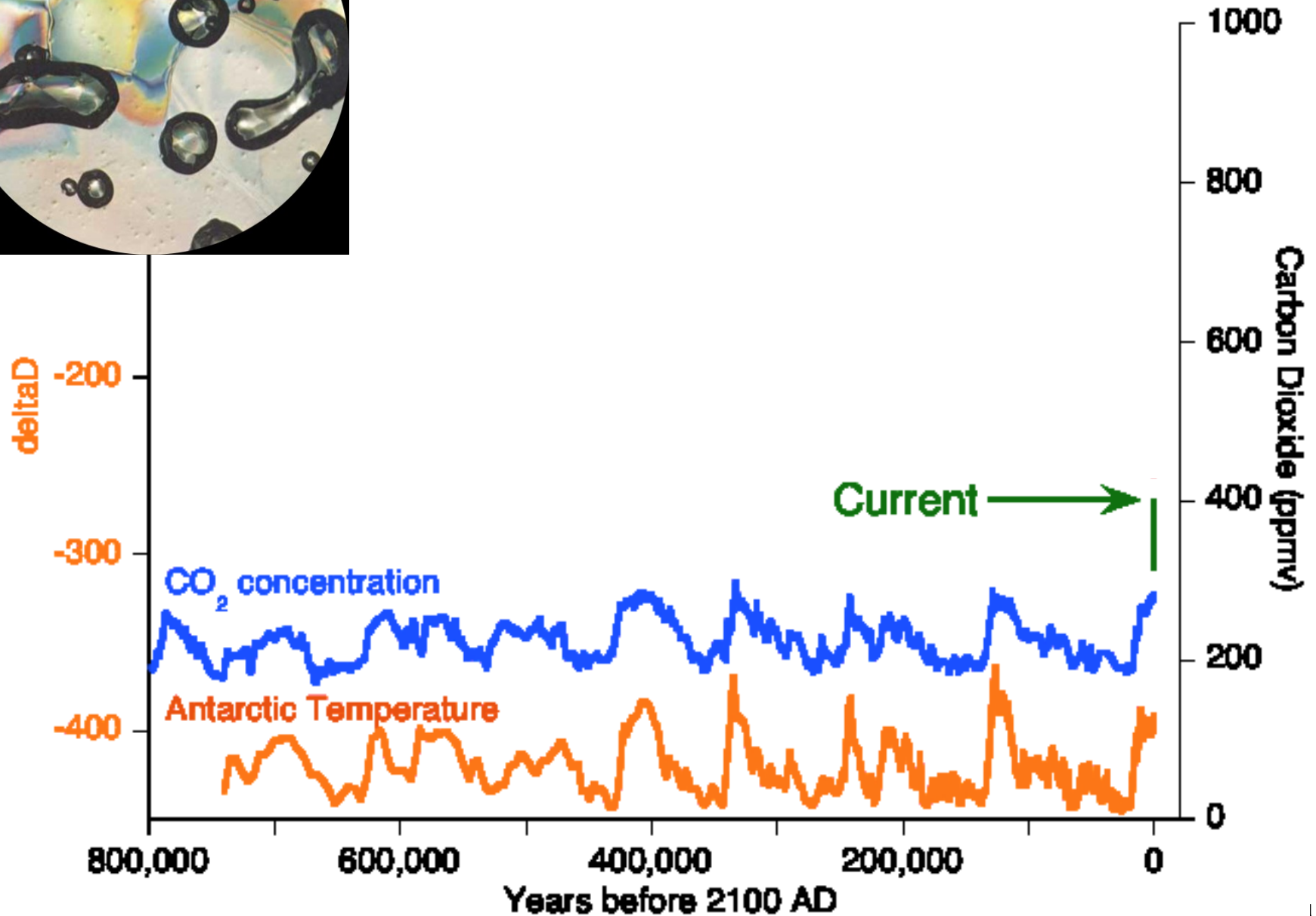
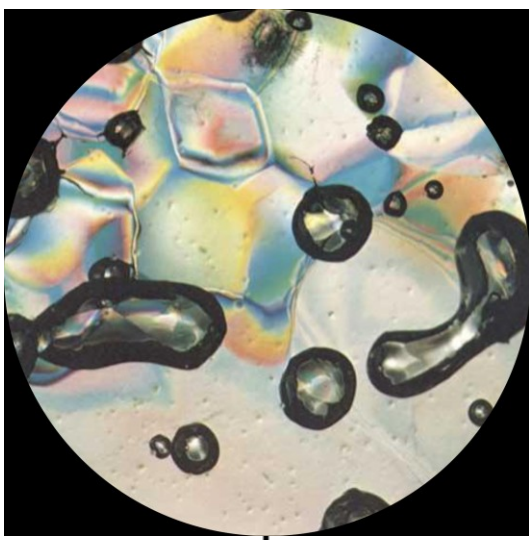




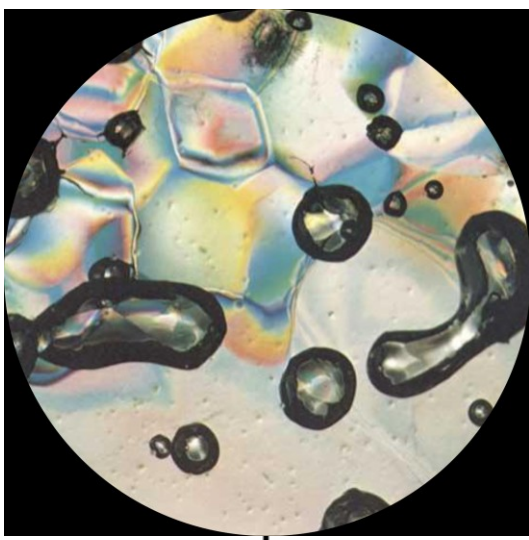
Temperature & Carbon Dioxide



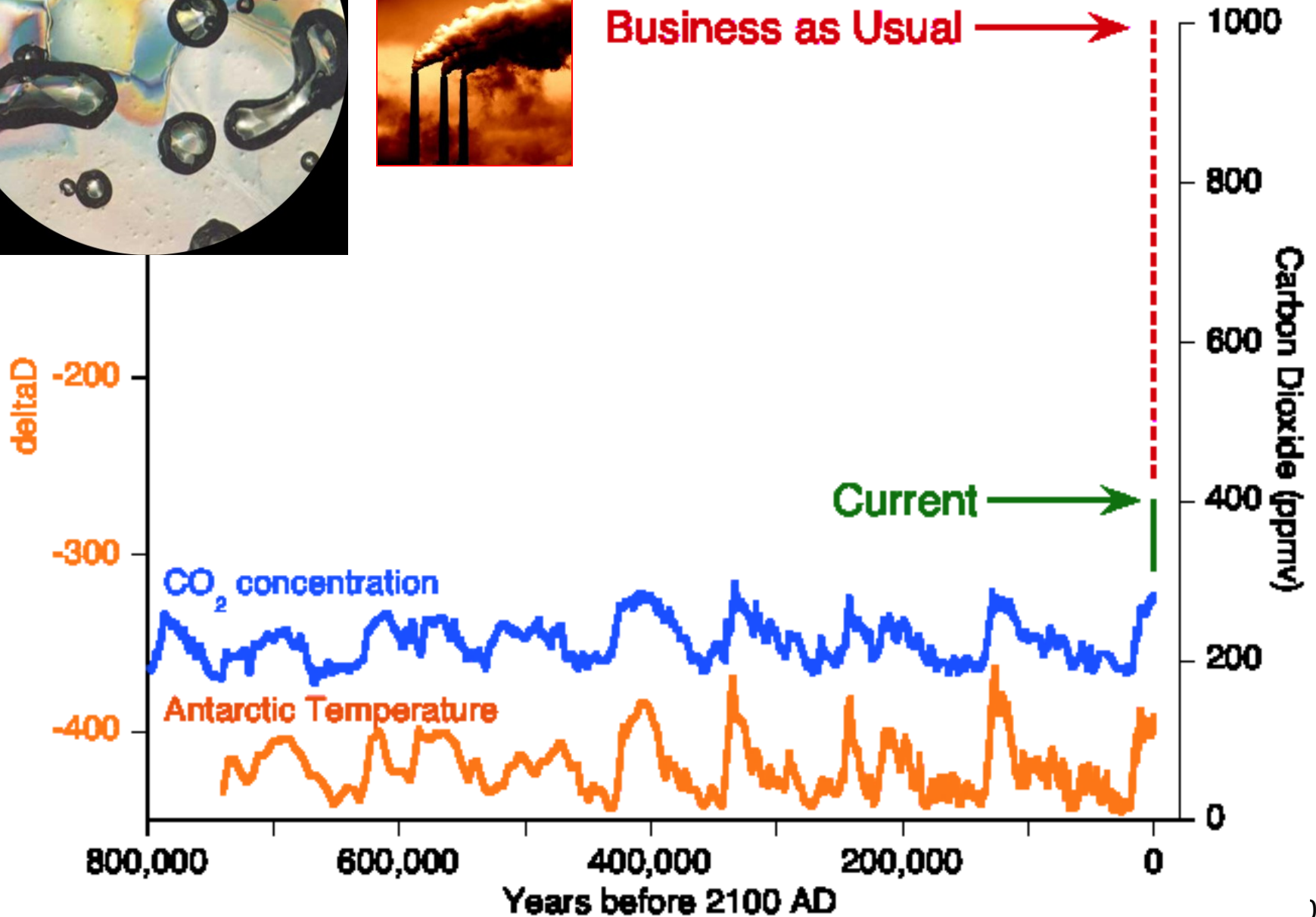
Temperature & Carbon Dioxide



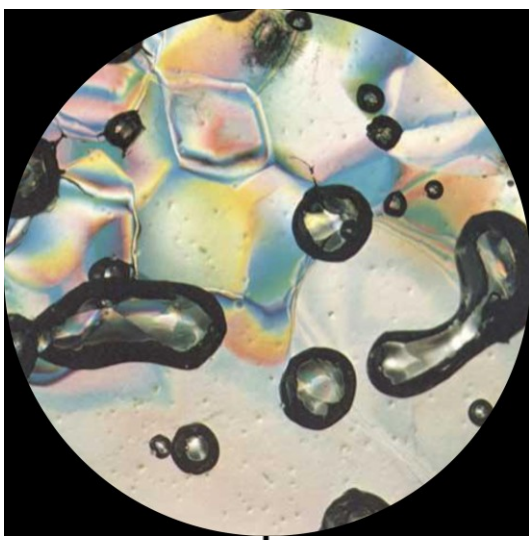
Temperature & Carbon Dioxide



Business as Usual →



Temperature & Carbon Dioxide

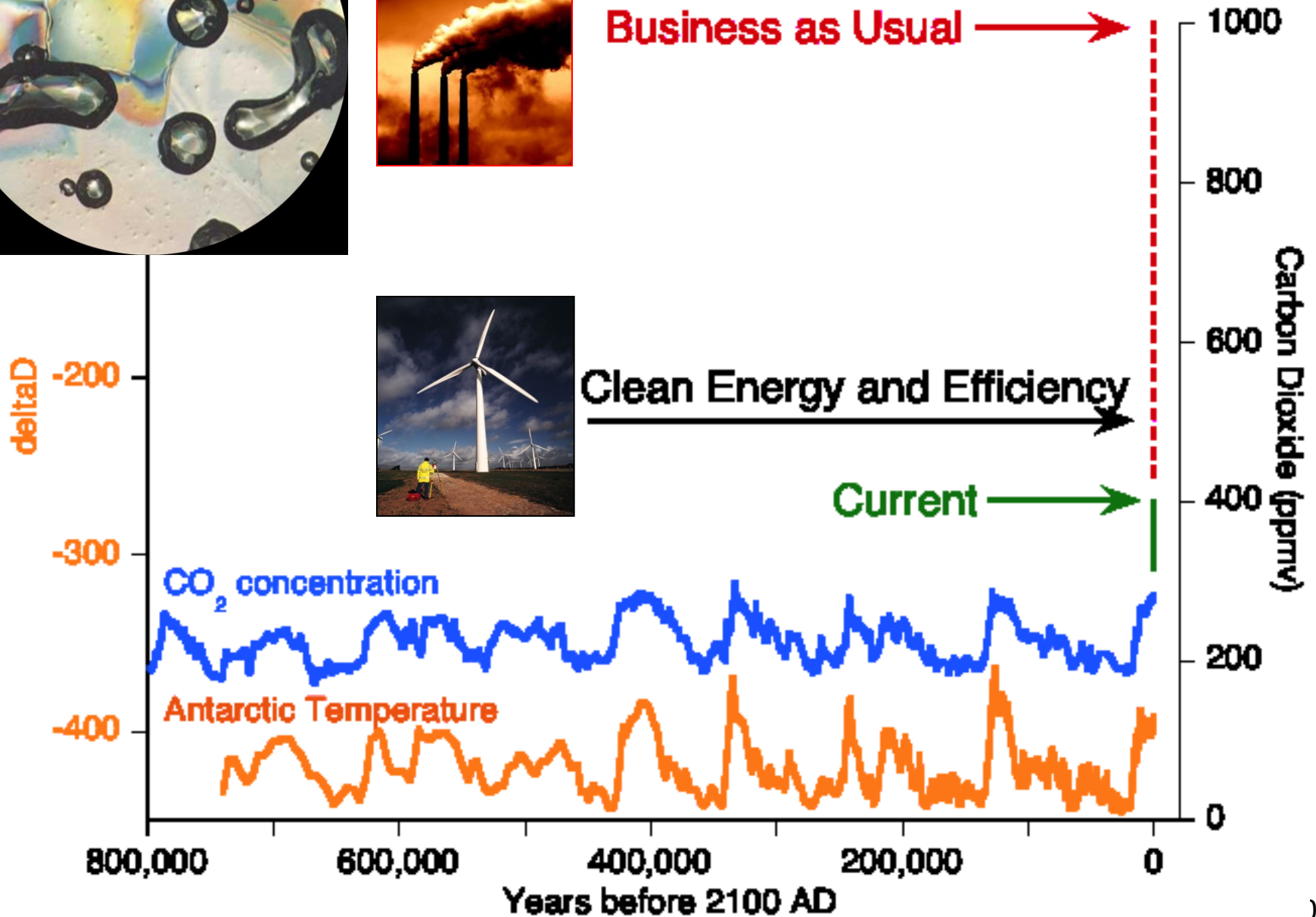


Business as Usual →

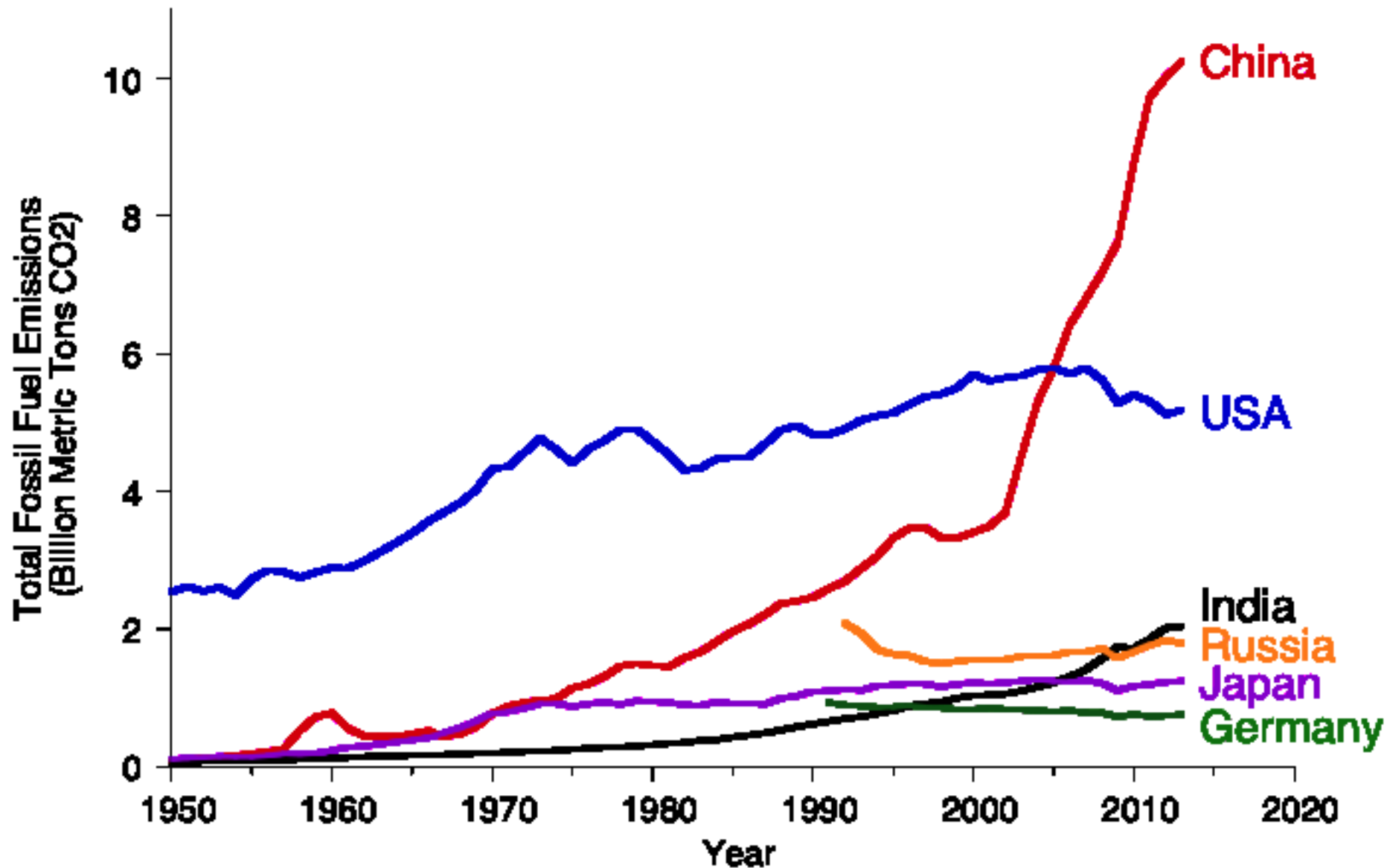


Clean Energy and Efficiency →

Current →



Top 6 Countries: Fossil Fuel Carbon Emissions



Global Climate Dashboard

▼ Climate Change

► Climate Variability

► Climate Projections

Global Average Temperature (°C)

The temperature near Earth's surface is rising: the bars show each year's average temperature compared to the 20th century average.

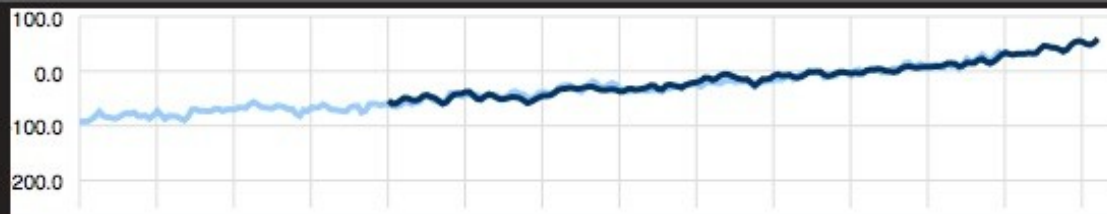
[learn more >>](#)



Global Average Sea Level (mm)

Sea level rise has accelerated from 1.7 mm/year throughout most of the twentieth century to 3.2 mm/year since 1993.

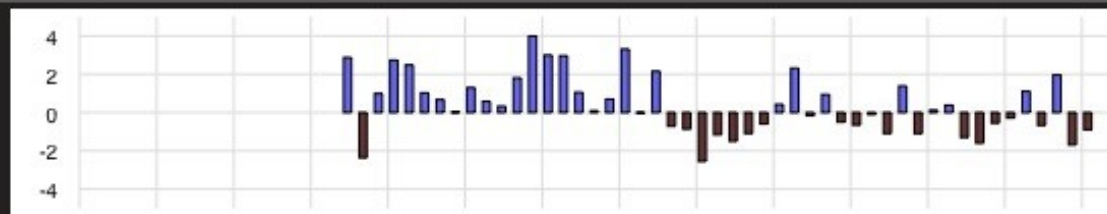
[learn more >>](#)



Spring Snow Cover (million km²)

Snow is melting earlier: each bar shows spring snow cover in the Northern Hemisphere compared to the long-term average.

[learn more >>](#)



1950

1955

1960

1965

1970

1975

1980

1985

1990

1995

2000

2005

2010

2015

← Earlier

Later →



Temperature



Carbon Dioxide



Snow



Sea Level



Arctic Sea Ice



Ocean Heat



Sun's Energy

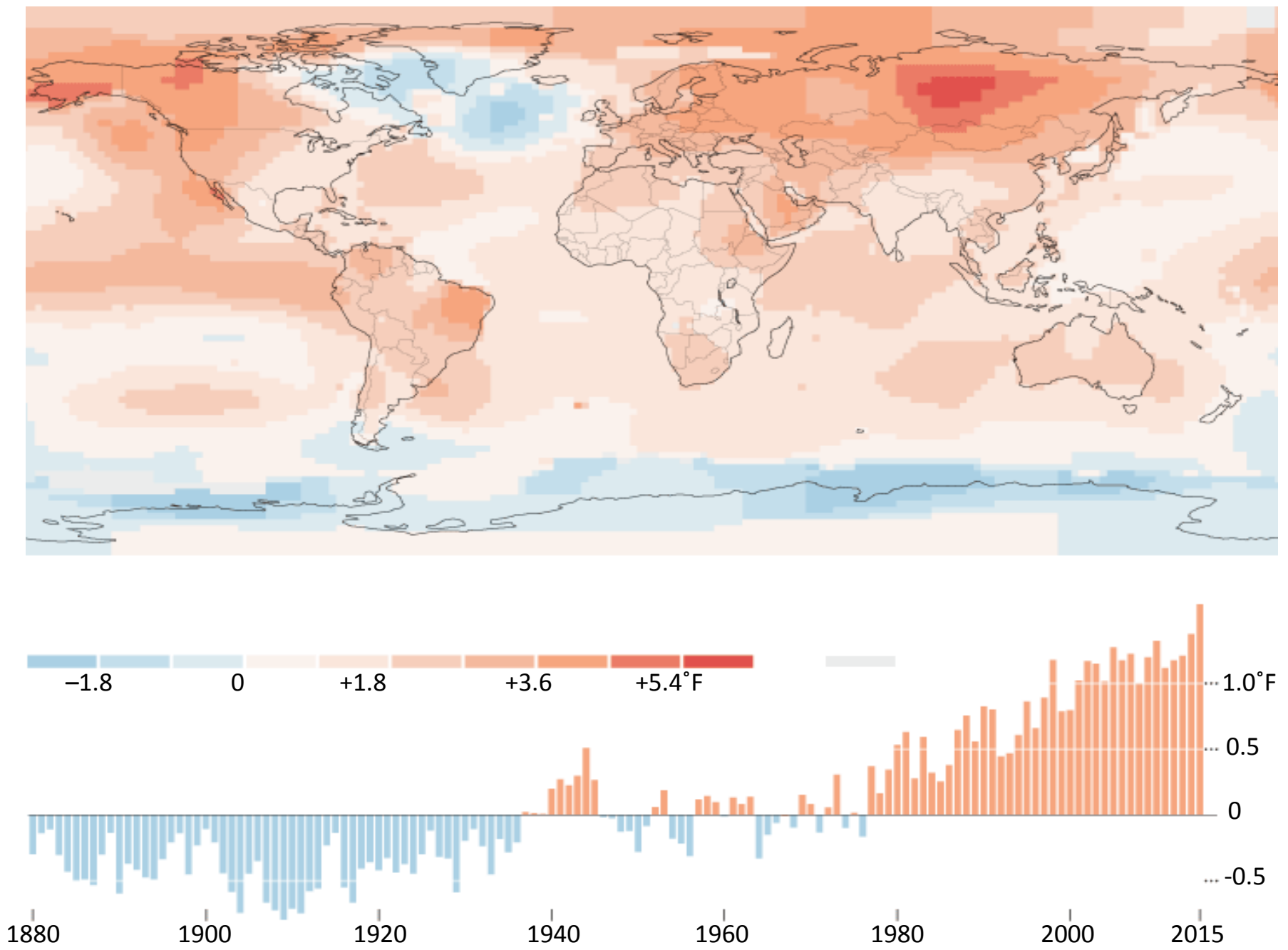


Glaciers



Heat-Trapping Gases

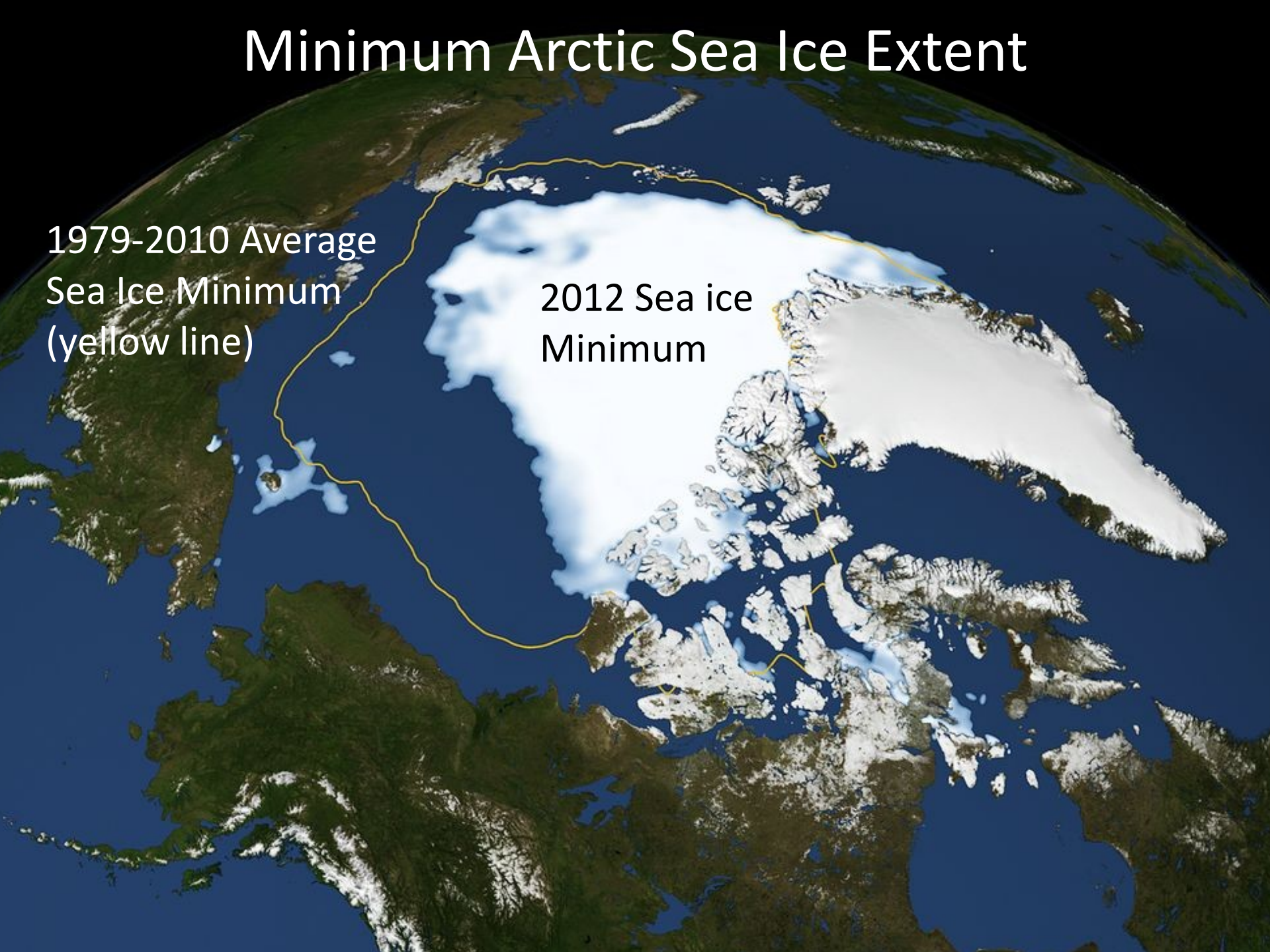
Average Global Surface Air Temperatures 1880 – 2015 (From NASA GISS)



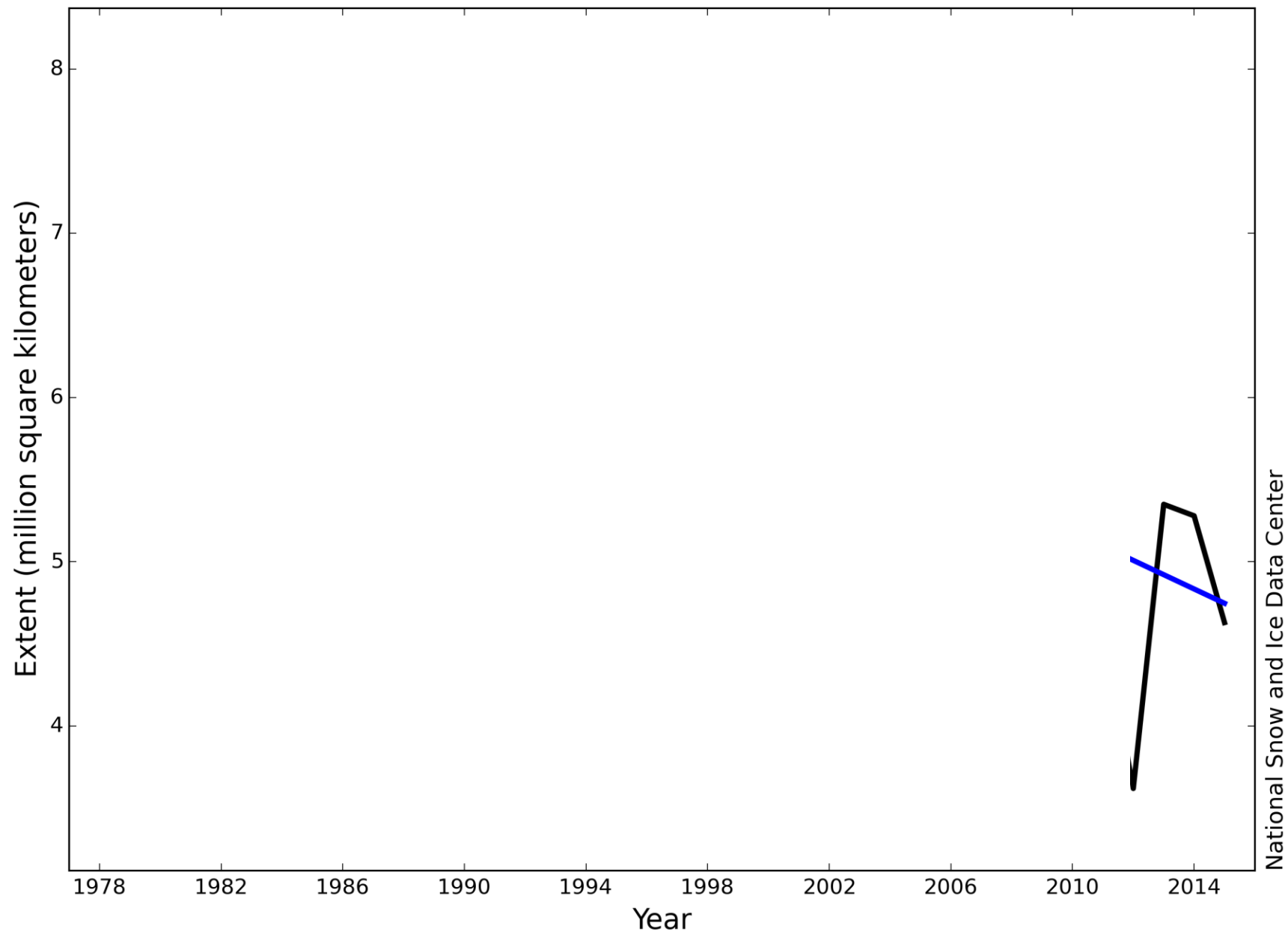
Minimum Arctic Sea Ice Extent

1979-2010 Average
Sea Ice Minimum
(yellow line)

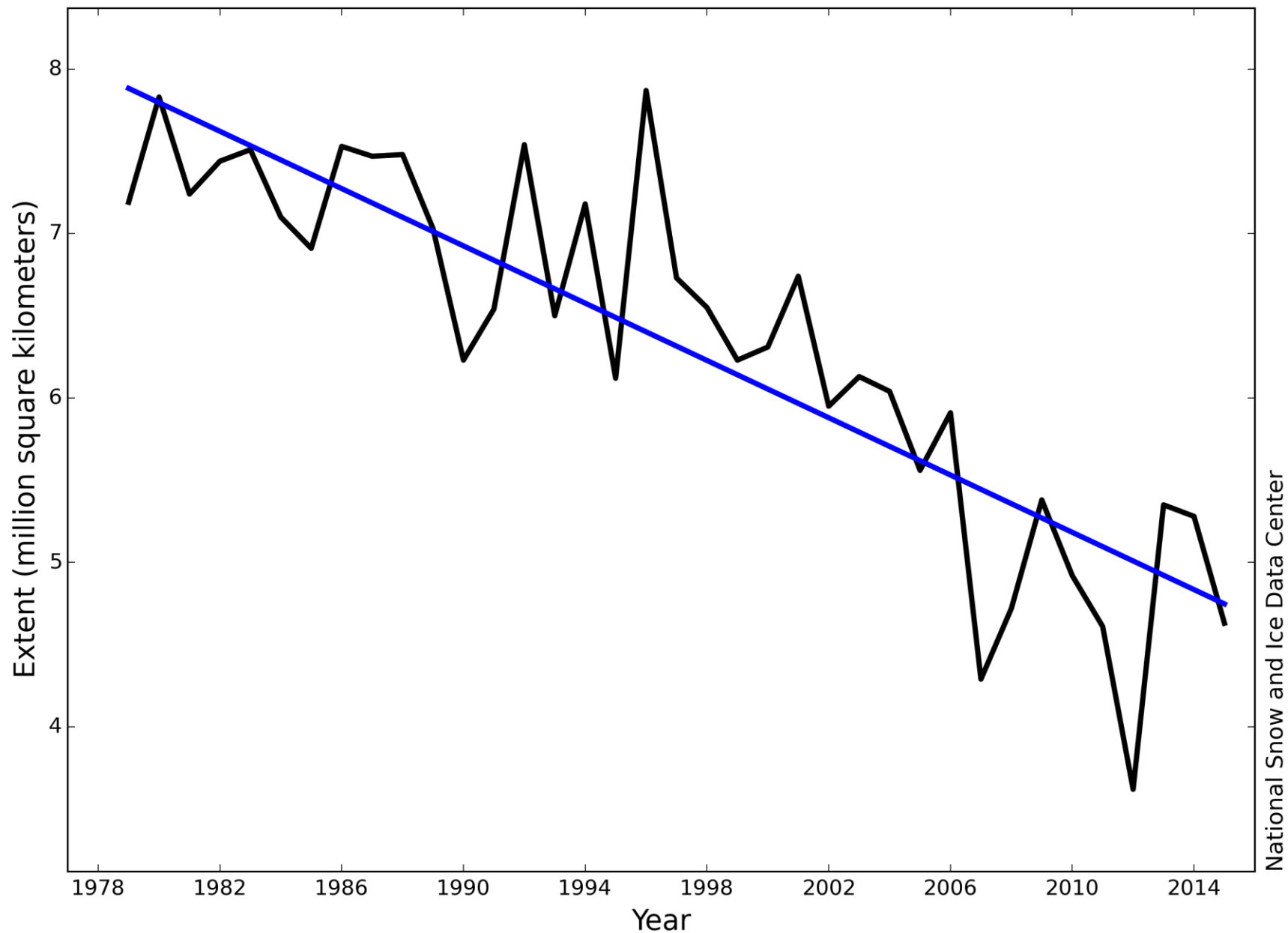
2012 Sea ice
Minimum



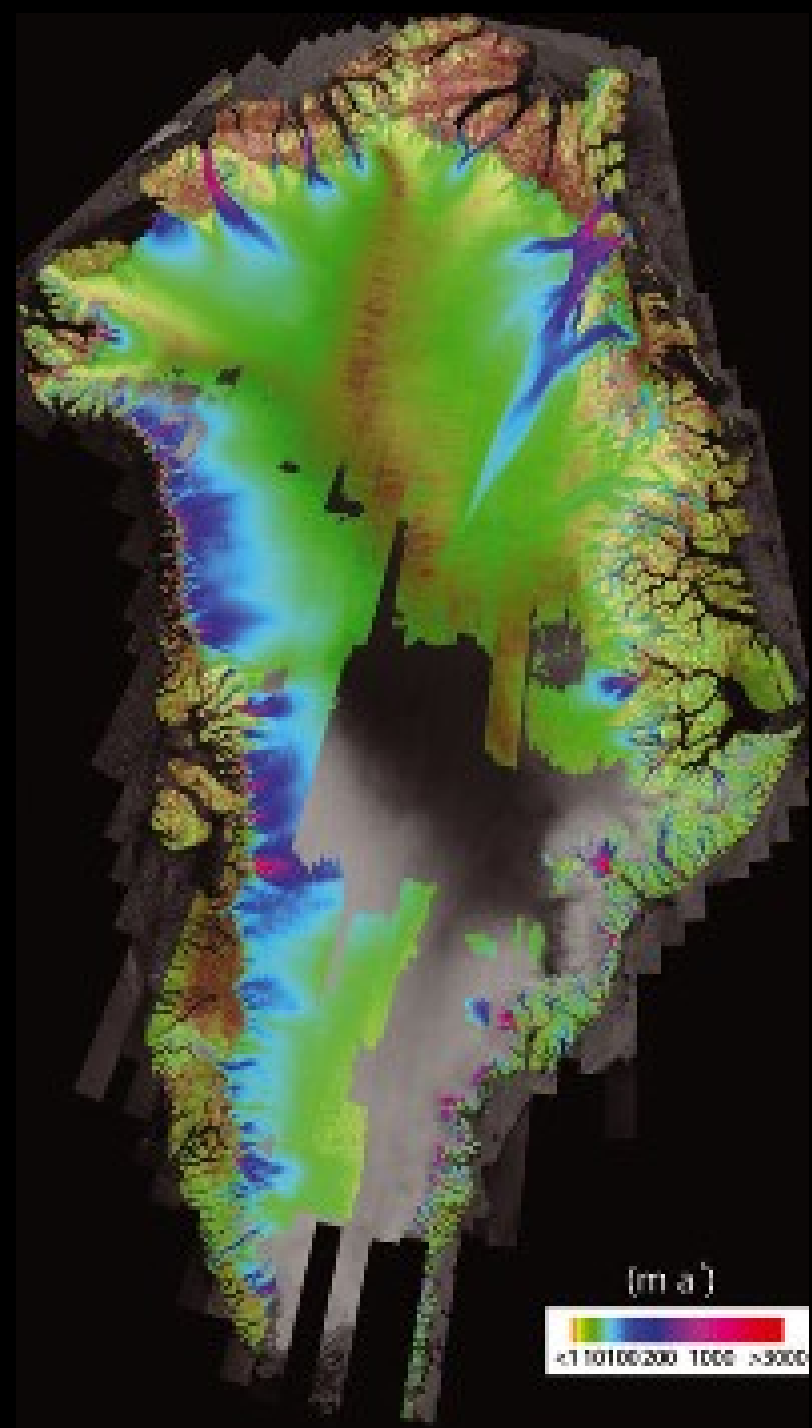
Average Monthly Arctic Sea Ice Extent September 1979 - 2015



Average Monthly Arctic Sea Ice Extent September 1979 - 2015

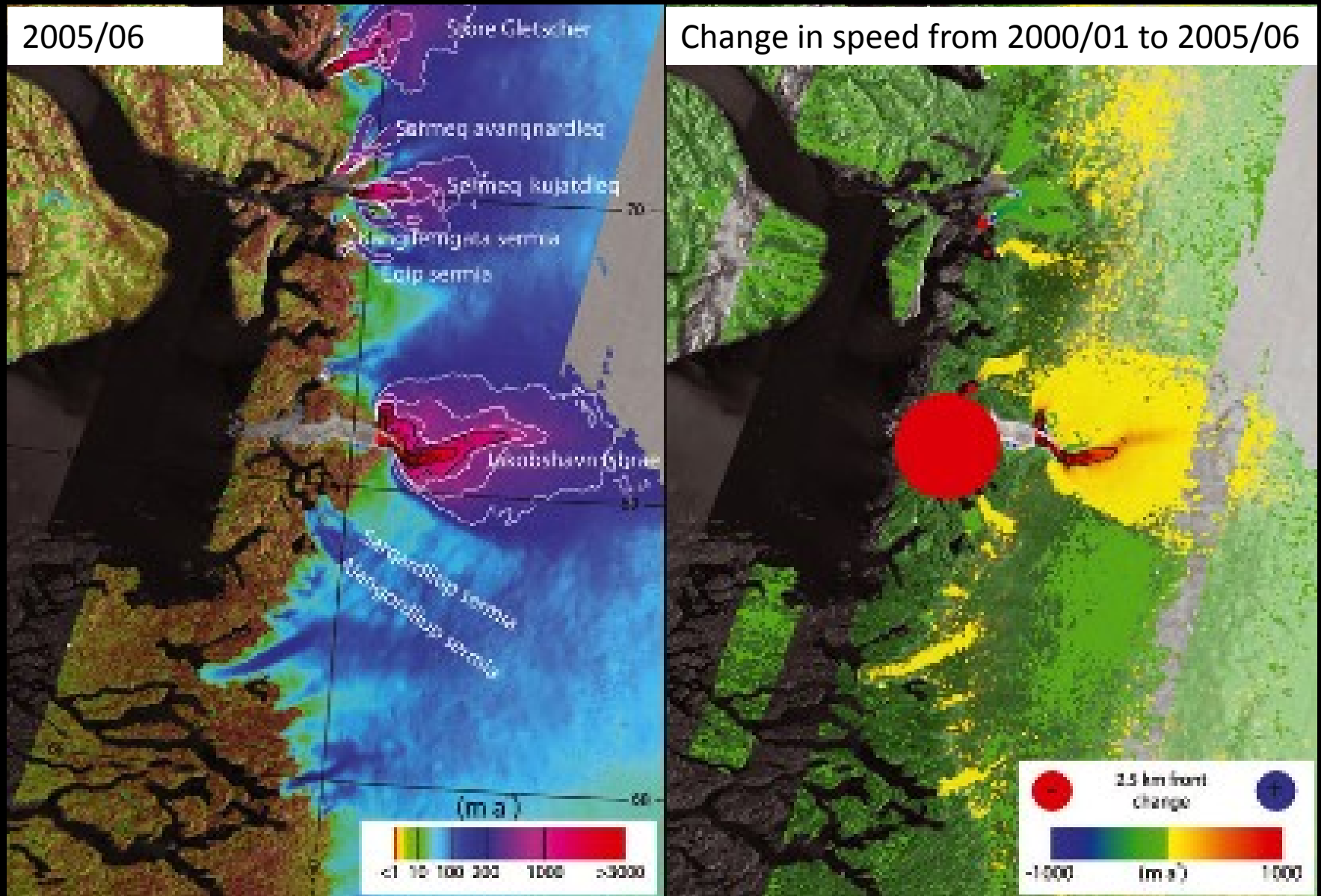


Flow Velocity Greenland Ice Sheet 2005-2006

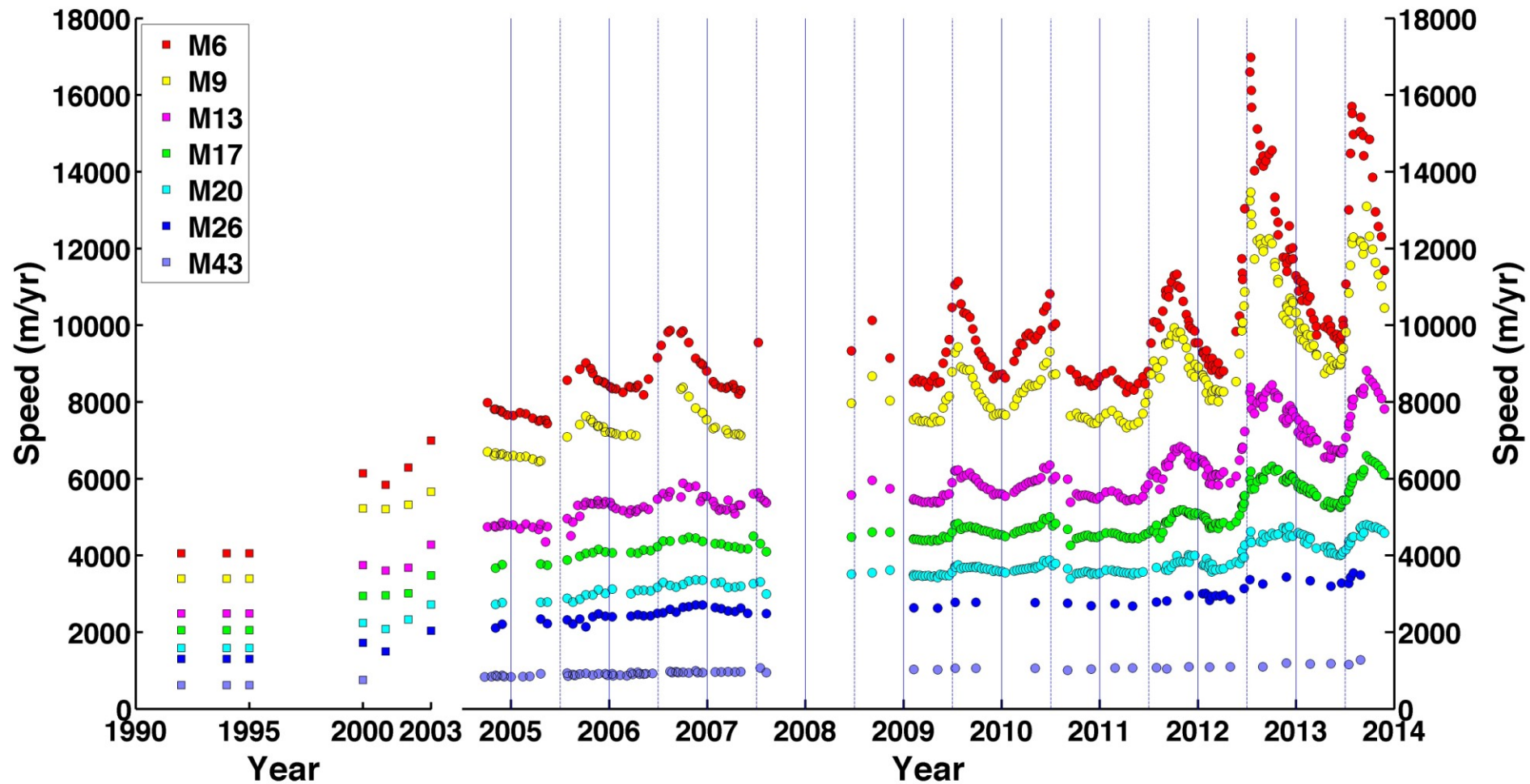


Joughin et al. (2010) Journal of
Glaciology, 56, 415-430.

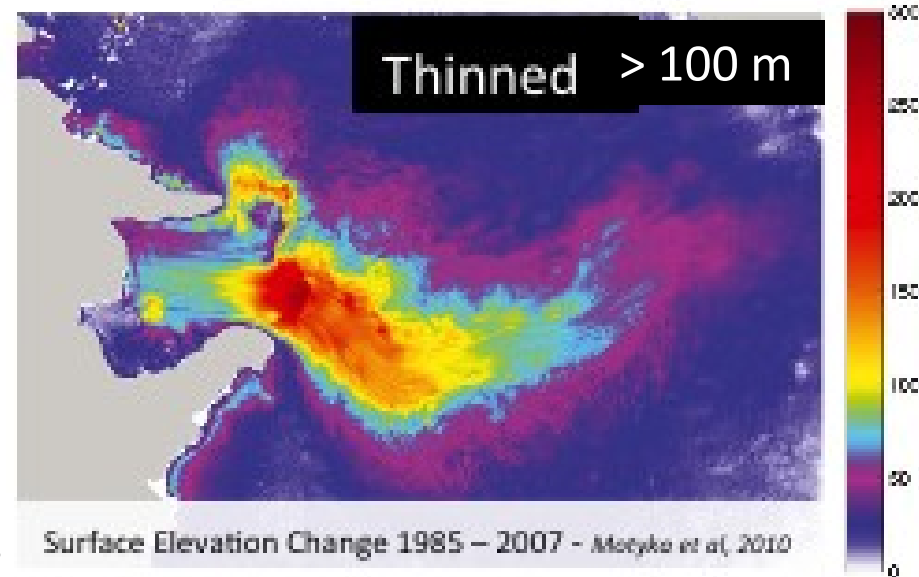
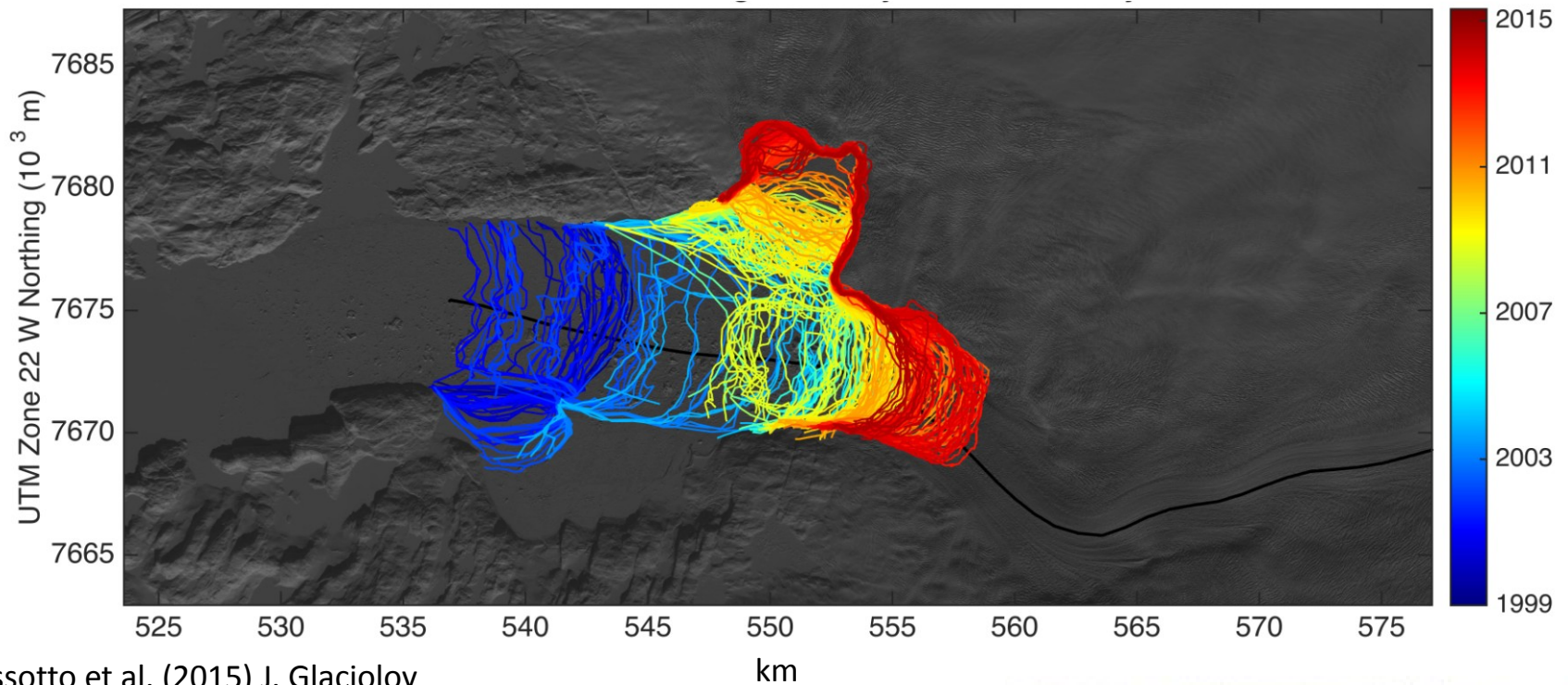
Flow Velocity of Jakobshavn Glacier



Jakobshavn Glacier: Dramatic Increase in Surface Velocity since 2000

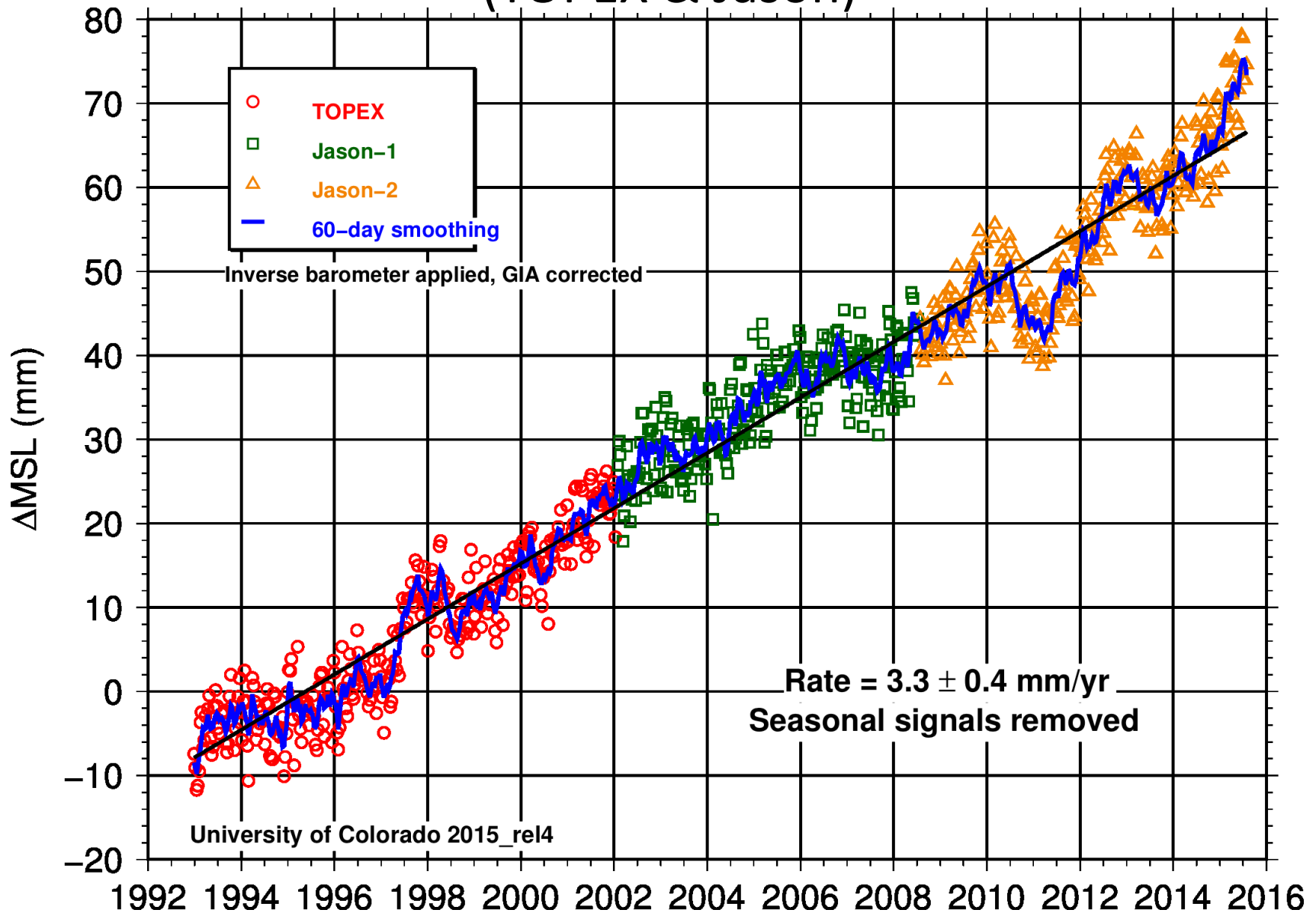


Jakobshavn Glacier: Retreat 1999 – 2015 > 17 km



Motyka RJ et al (2010) J. Glaciology.

Global Mean Sea Level from Satellite Radar Altimeters (TOPEX & Jason)



Climate Change in the
Piscataqua/Great Bay Region:
Past, Present, and Future

New Hampshire Climate Assessments

ClimateSolutionsNE.org

Climate Change in Southern New Har

PAST, PRESENT, AND FUTURE

A PUBLICATION OF THE SUSTAINABILITY INSTITUTE AT THE UNIVERSITY OF NEW

Climate Change in Northern New Hampsh

PAST, PRESENT, AND FUTURE

A PUBLICATION OF THE SUSTAINABILITY INSTITUTE AT THE UNIVERSITY OF NEW HAMPSHIRE

Sea-level Rise, Storm Surges, and Extreme Precipitation in Coastal New Hampshire:

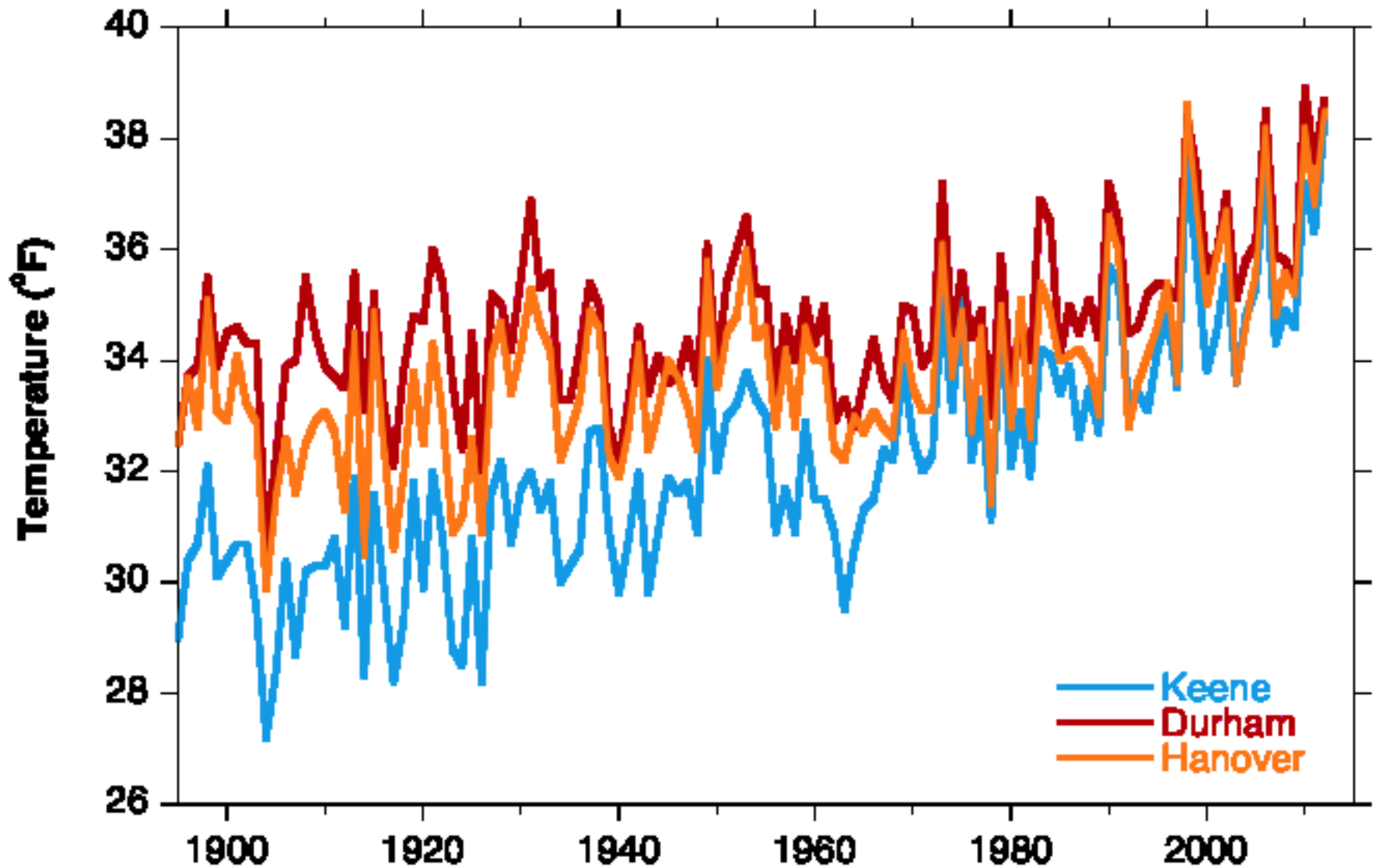
ANALYSIS OF PAST AND PROJECTED TRENDS

A PUBLICATION OF THE SUSTAINABILITY INSTITUTE AT THE UNIVERSITY OF NEW HAMPSHIRE



Southern NH : Average Annual MINIMUM Temperature 1895 – 2012

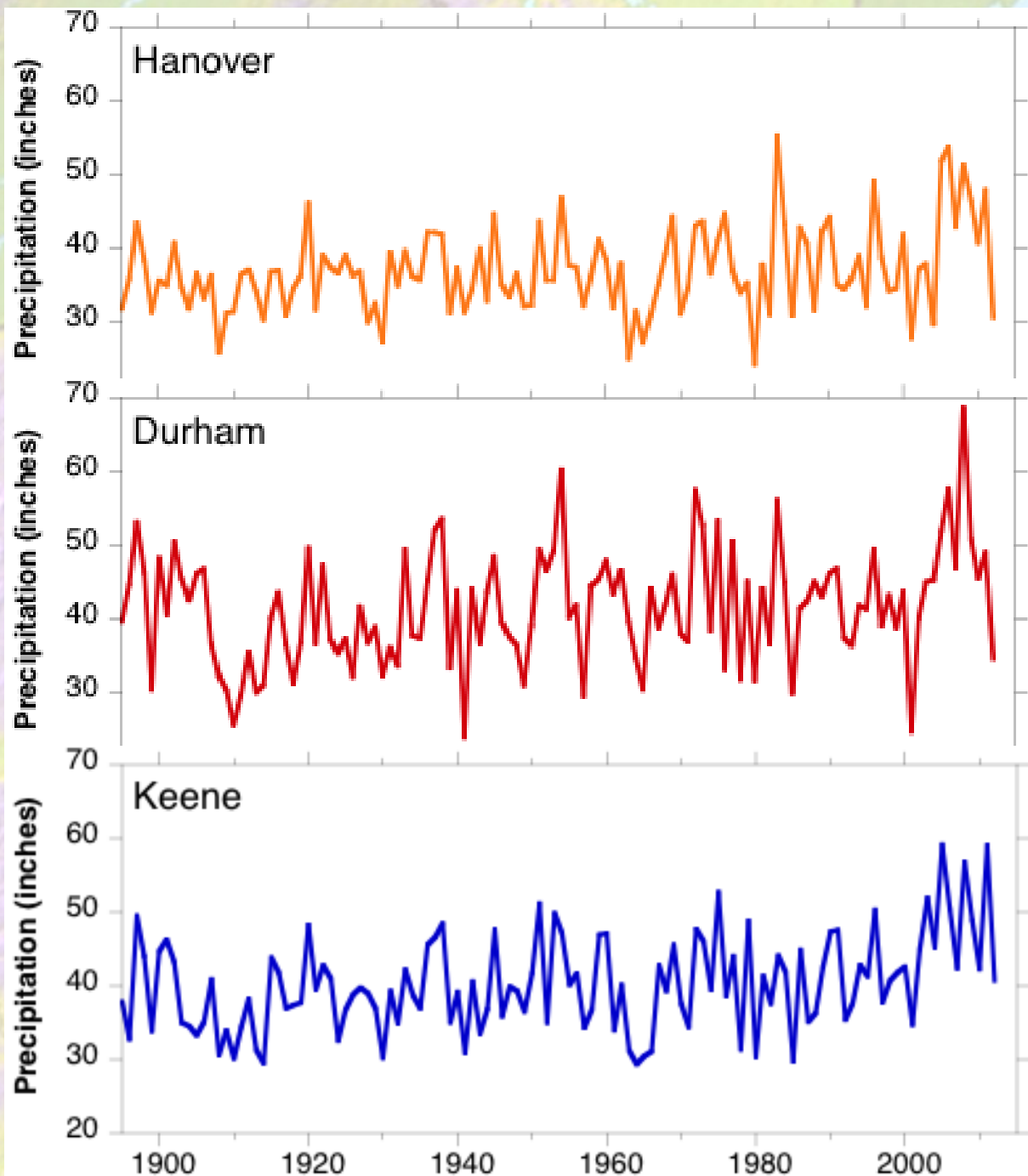
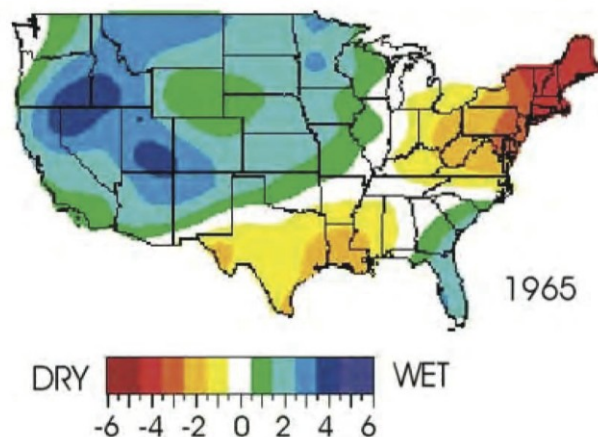
Monthly data from US Historical Climatology Network



Southern NH Annual Precipitation 1895 – 2012

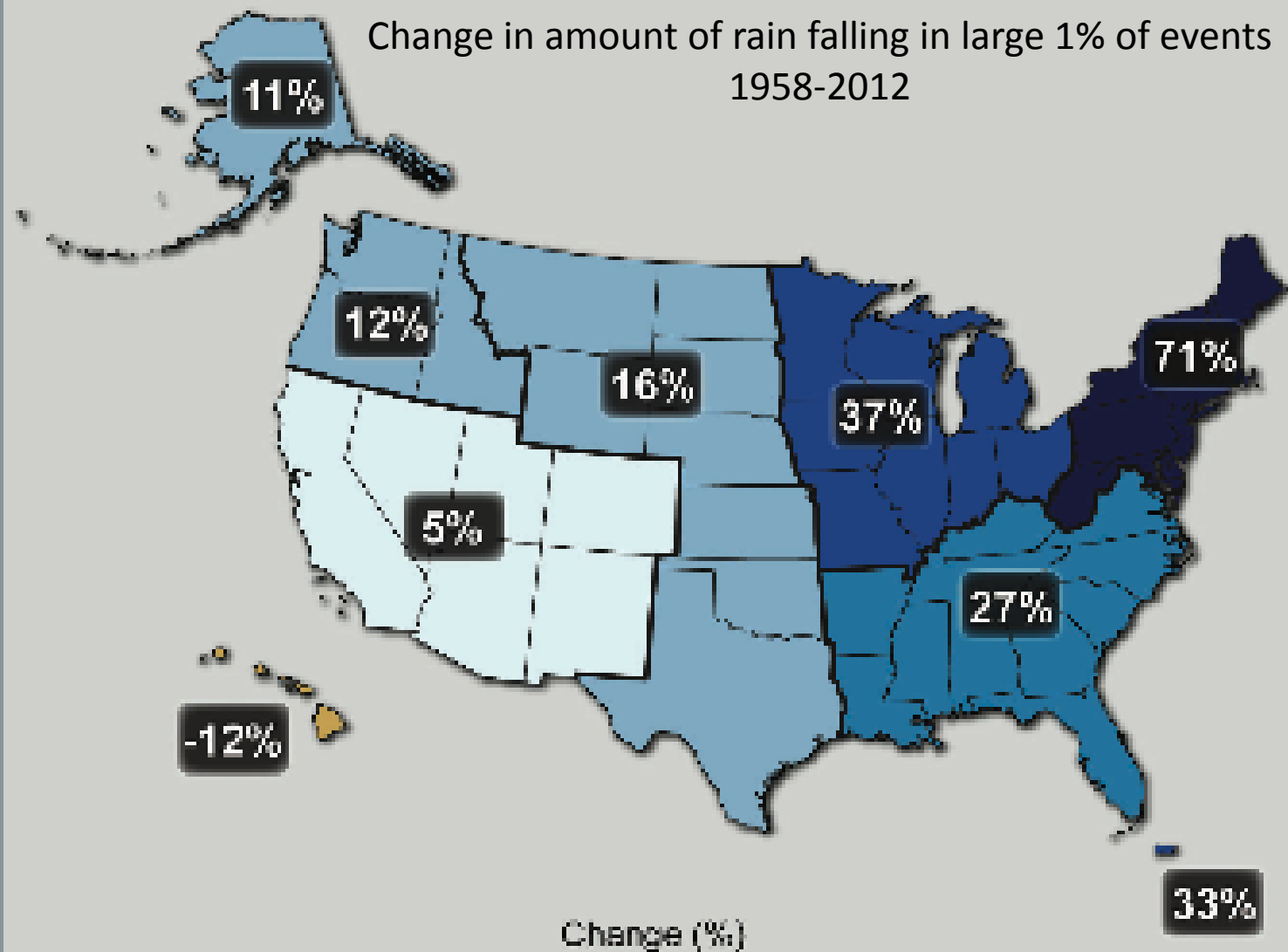
Monthly data from US
Historical Climatology Network

Palmer Drought Severity Index



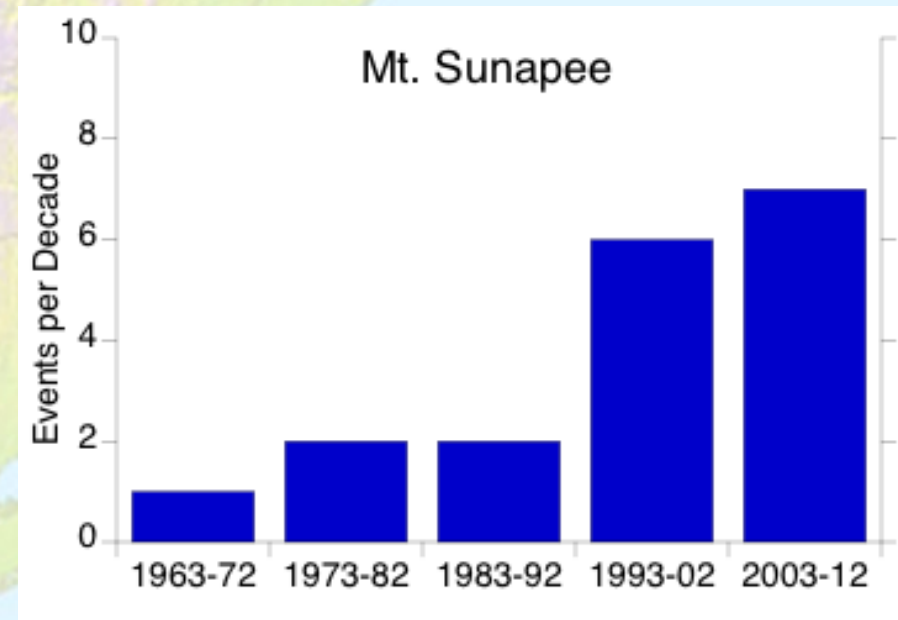
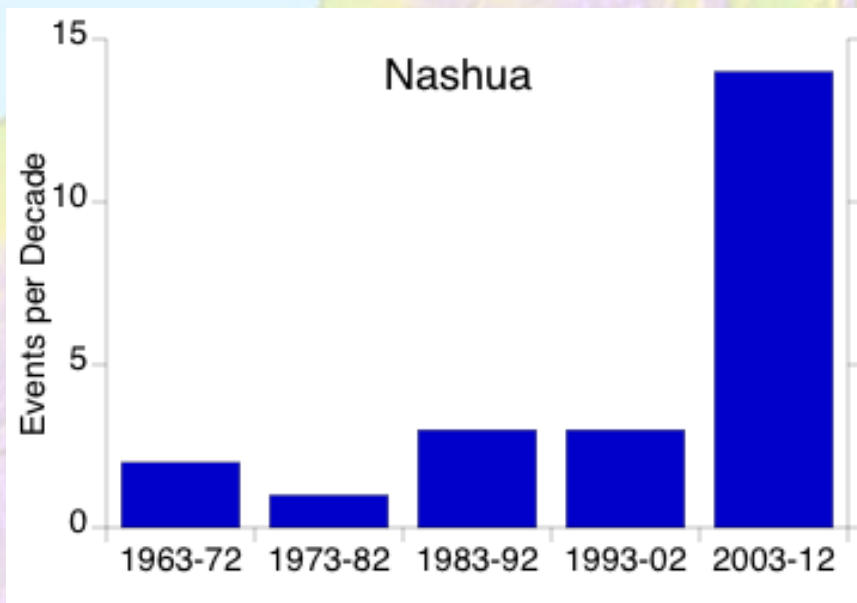
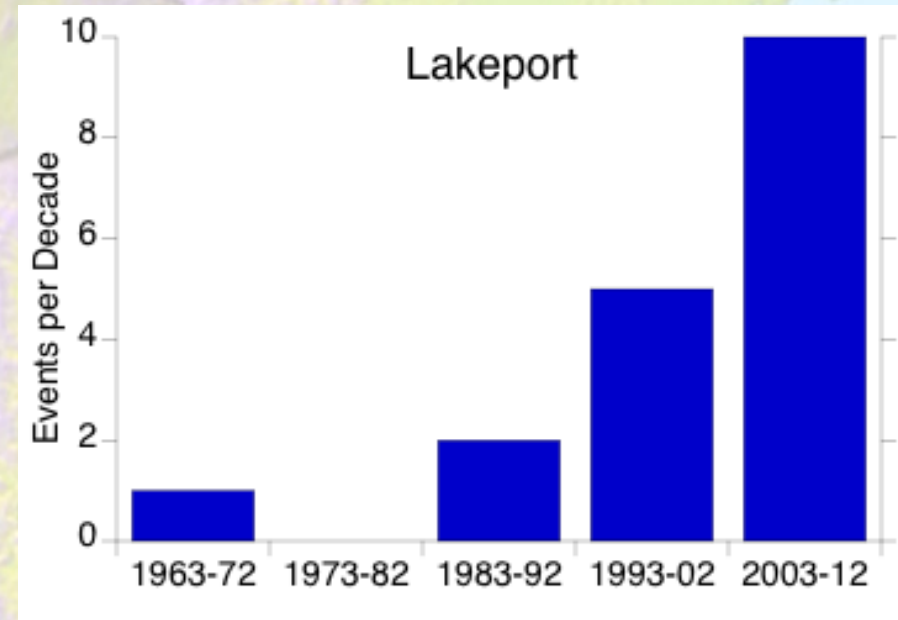
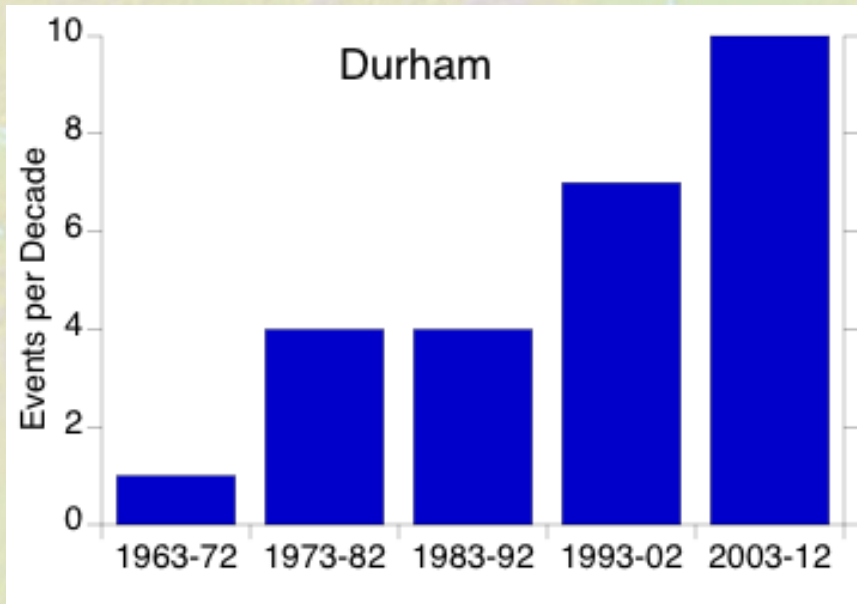
Observed Change in Very Heavy Precipitation

Change in amount of rain falling in large 1% of events
1958-2012

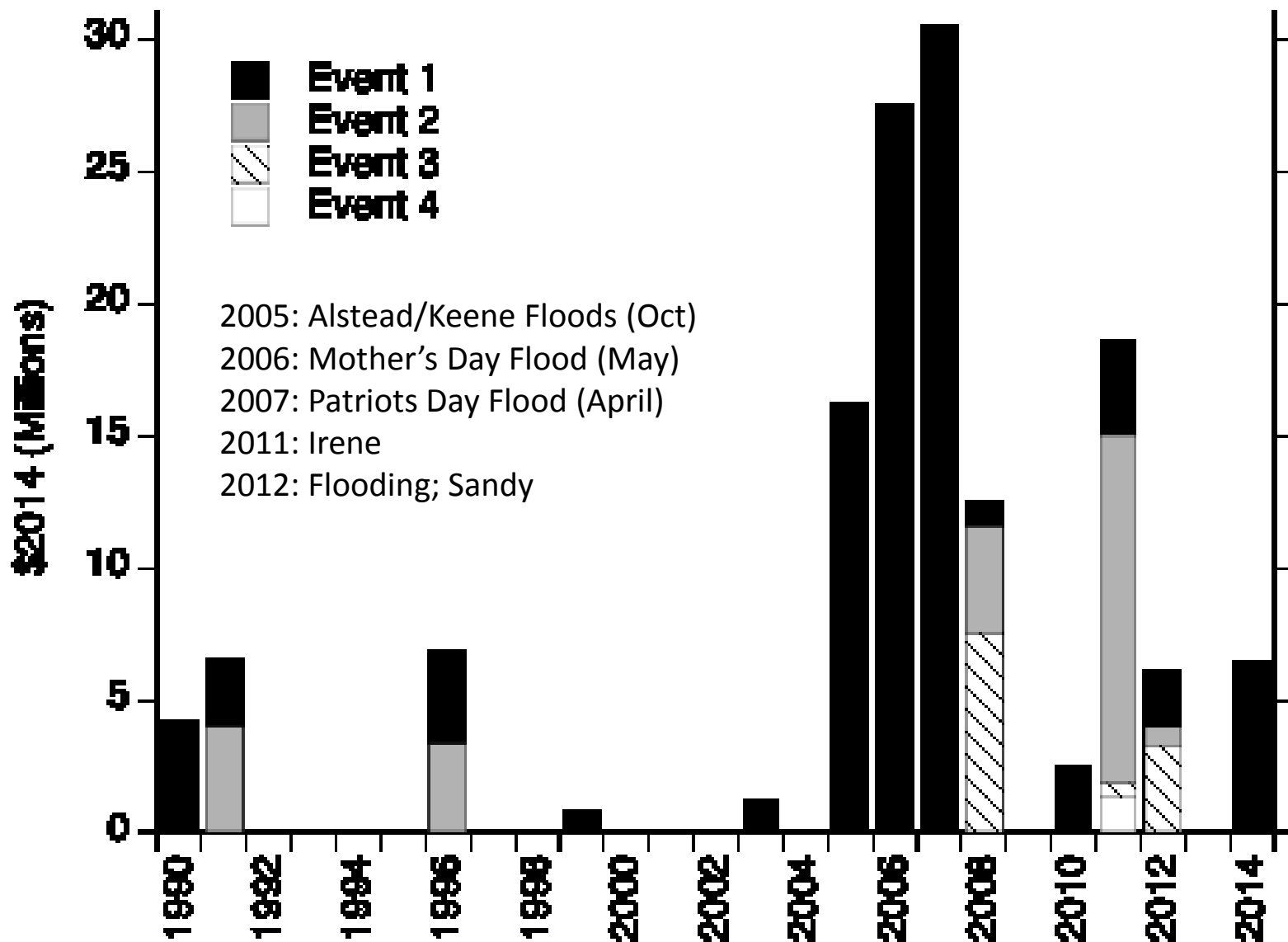


Precipitation Events >4" in 48 hrs per Decade

Daily data from US Global Historical Climatology Network

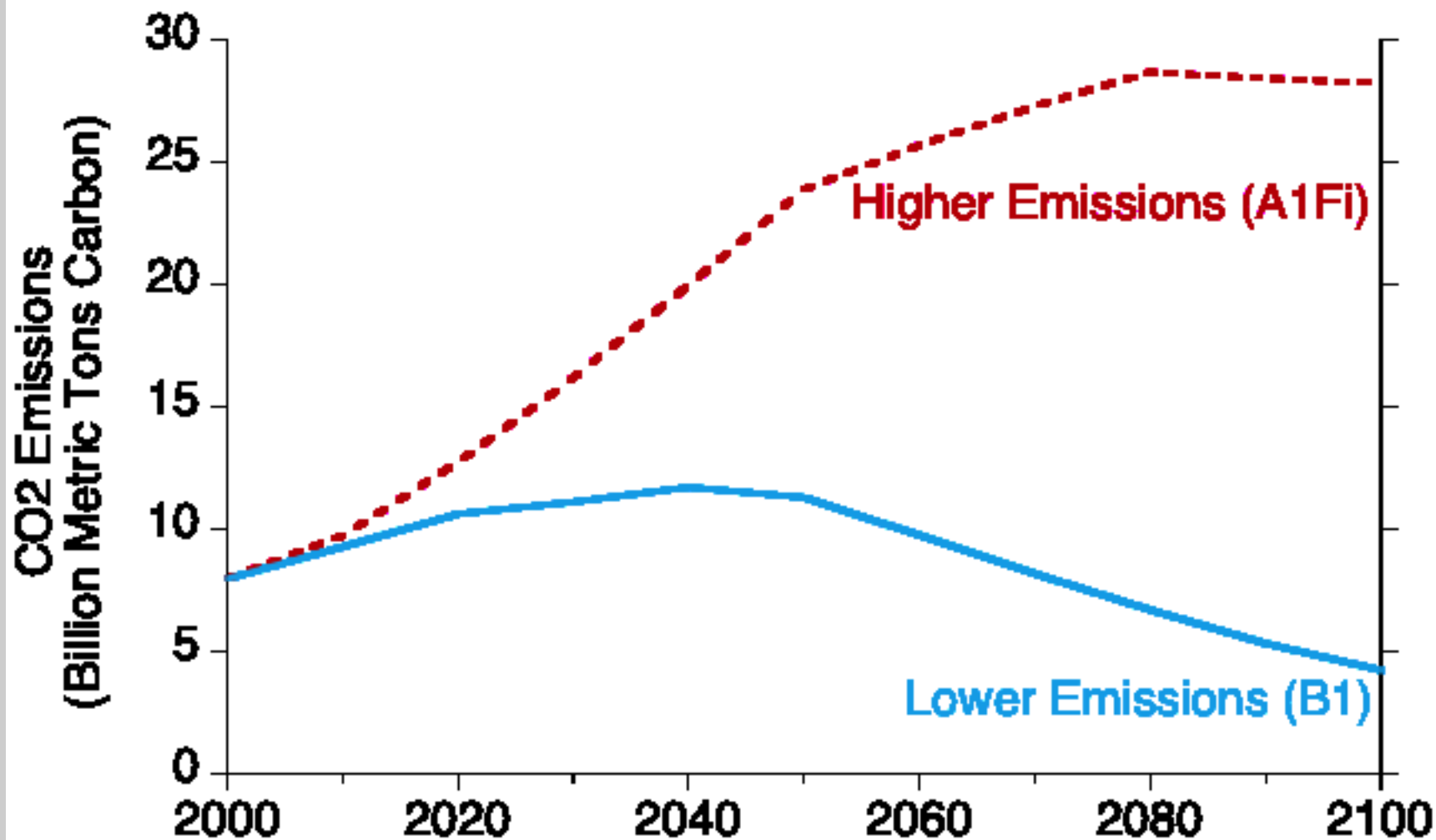


Federal Expenditures on FLOOD RELATED Presidentially Declared Disasters And Emergency Declarations in NH

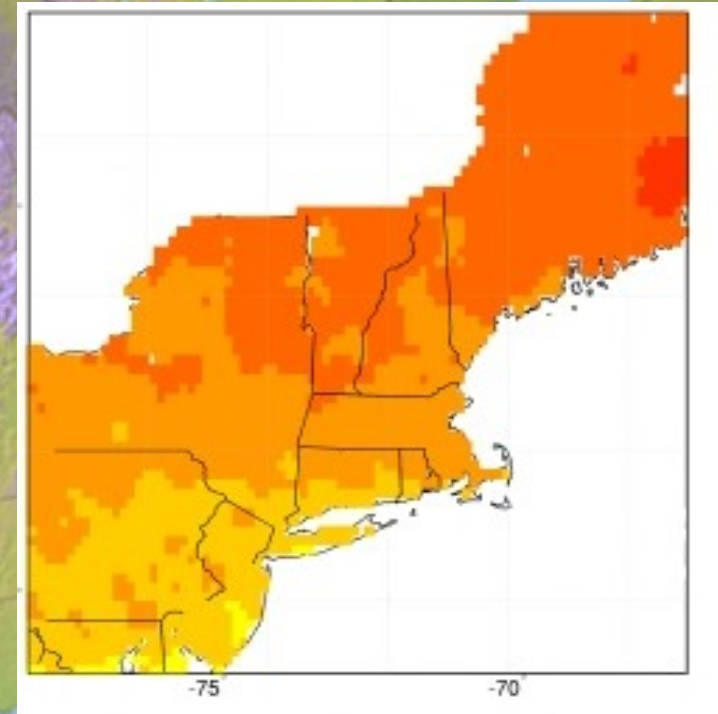
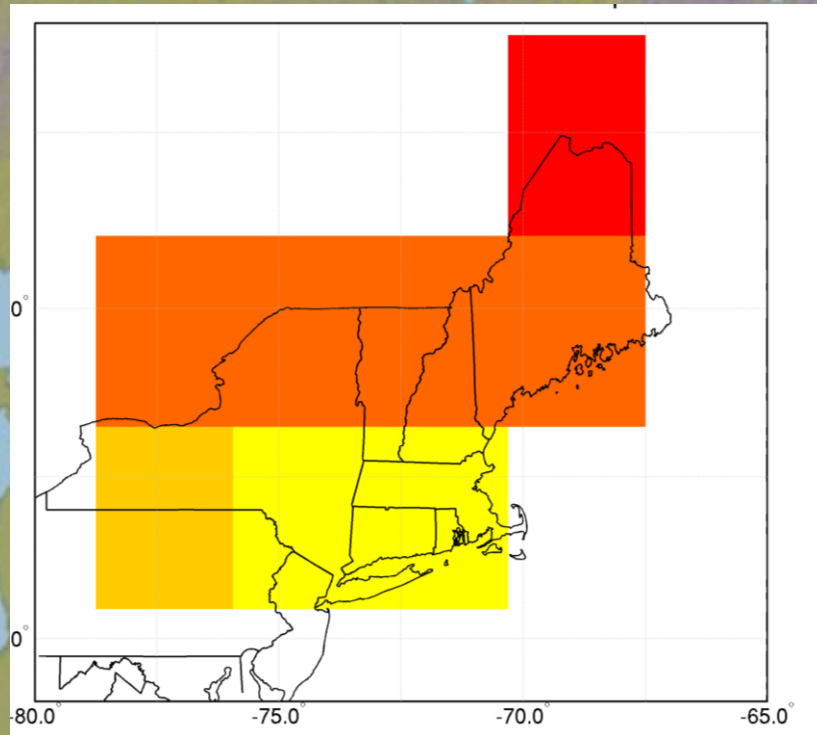


Global Greenhouse Gas Emission Scenarios

Key Input for GCM projections of future climate change



Projecting Future Climate Change for the Northeast: Downscale Global Projections to Regional Level



Projections from 4 different global climate models:

NOAA – GFDL

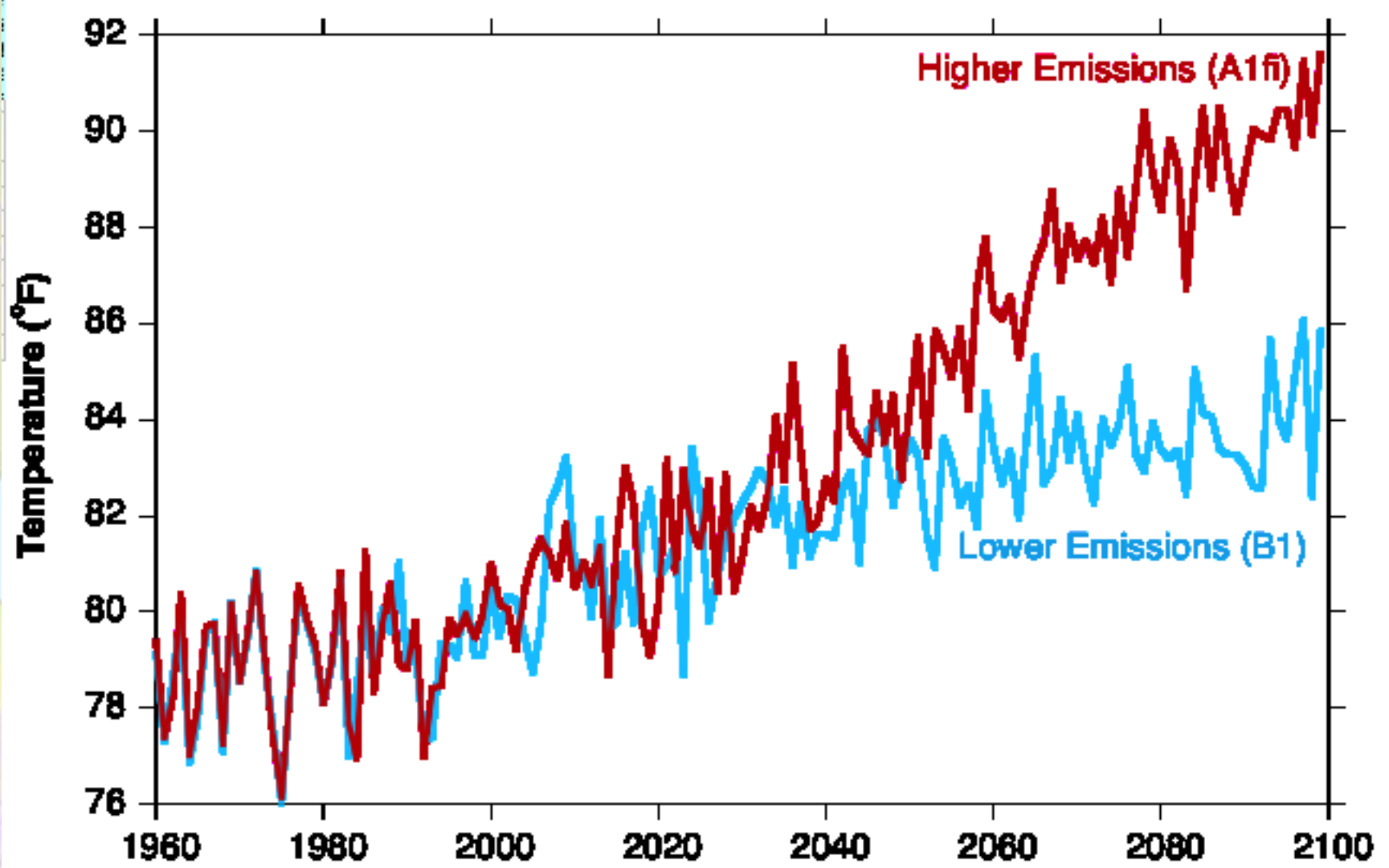
UKMO – HadCM3

NCAR – PCM

NCAR – CCSM3

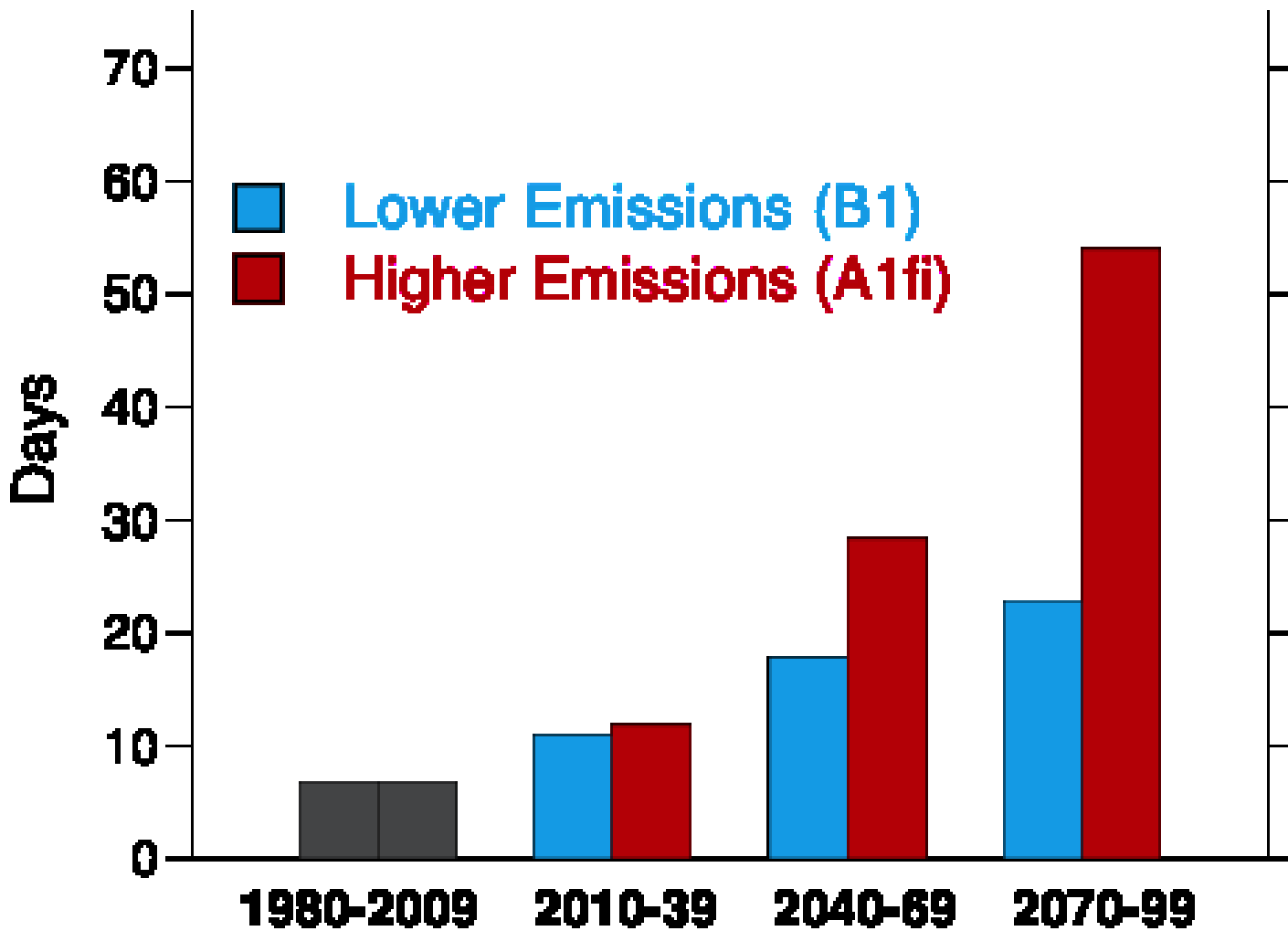
Southern NH: Average Summer MAXIMUM Temperature 1960-2099

Average of statistically downscaled simulations from 4 GCMs



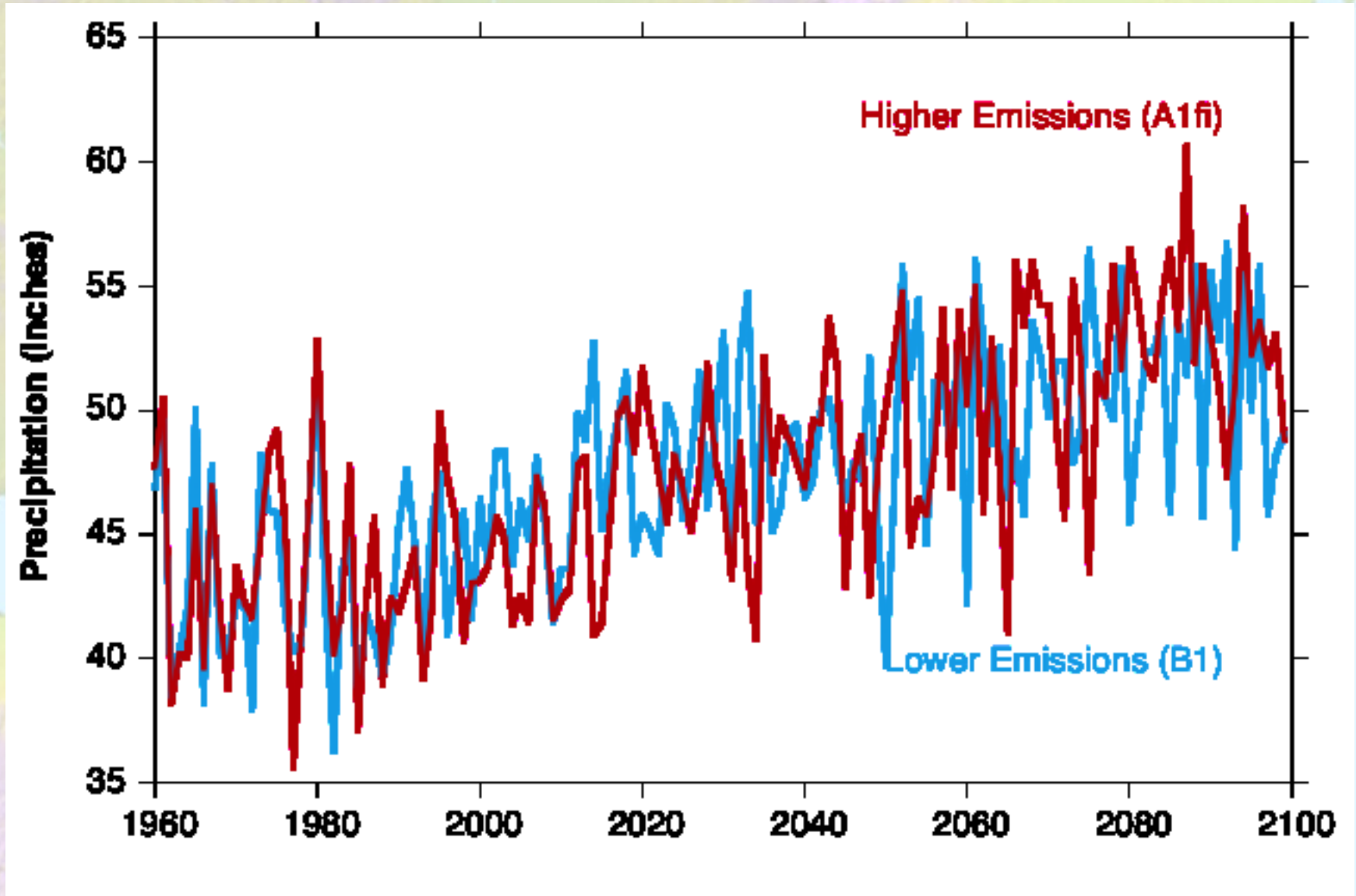
Southern NH: Number of Days Hotter than 90°F (30 year averages)

Average of statistically downscaled simulations from 4 GCMs



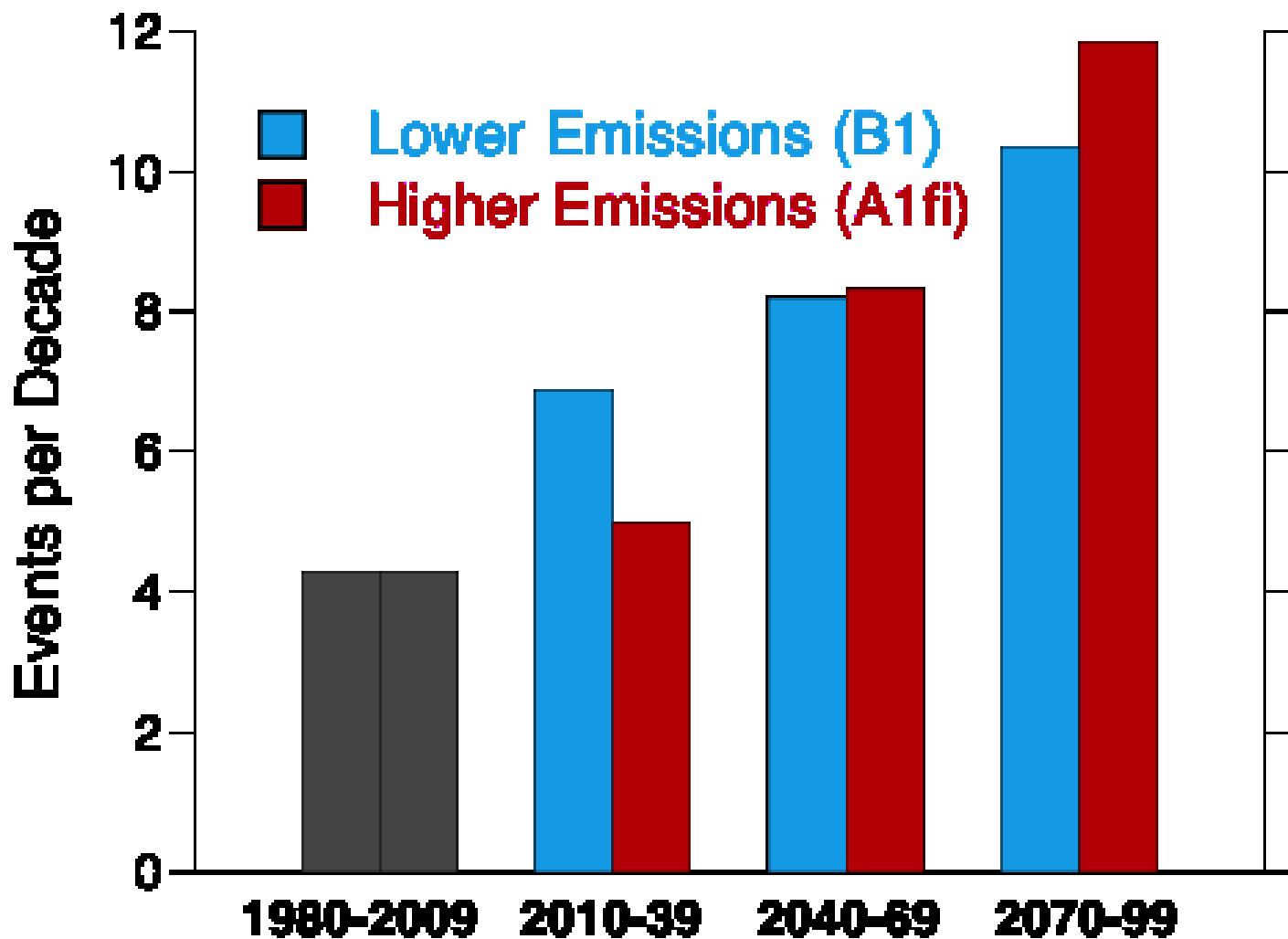
Southern NH: Average Annual Precipitation 1960-2099

Average of statistically downscaled simulations from 4 GCMs



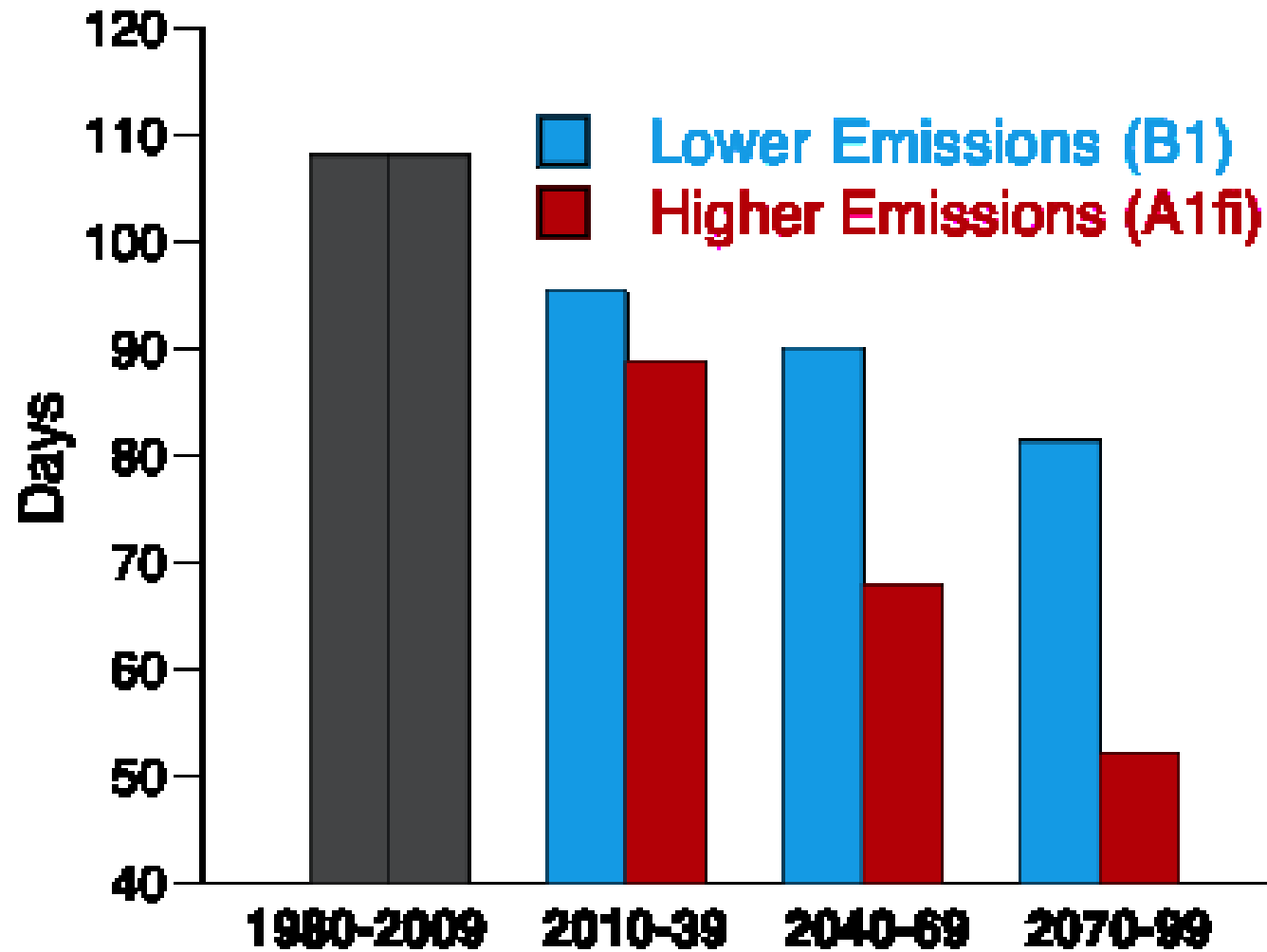
Southern NH: Precipitation Events >4" in 48 hrs per Decade

Average of statistically downscaled simulations from 4 GCMs



Southern NH: Days with Snow on the Ground

Average of statistically downscaled simulations from 4 GCMs



Sea-level Rise, Storm Surges, and Extreme Precipitation in Coastal New Hampshire:

ANALYSIS OF PAST AND PROJECTED TRENDS

A PUBLICATION OF THE SUSTAINABILITY INSTITUTE AT THE UNIVERSITY OF NEW HAMPSHIRE

Prepared by:

Science and Technical Advisory Panel,
New Hampshire Coastal Risks & Hazards Commission
Coordinating Lead Authors:

Paul Kirshen (Chair, UNH), Cameron Wake (UNH)

Lead Authors:

Matt Huber (UNH), Kevin Knuuti (US ACE),
Mary Stampone (UNH and NH Climate Office)

Global sea levels have been rising and are expected to continue rising well beyond the end of 21st century.



External Reviewers:

Kerry Emanuel (MIT)

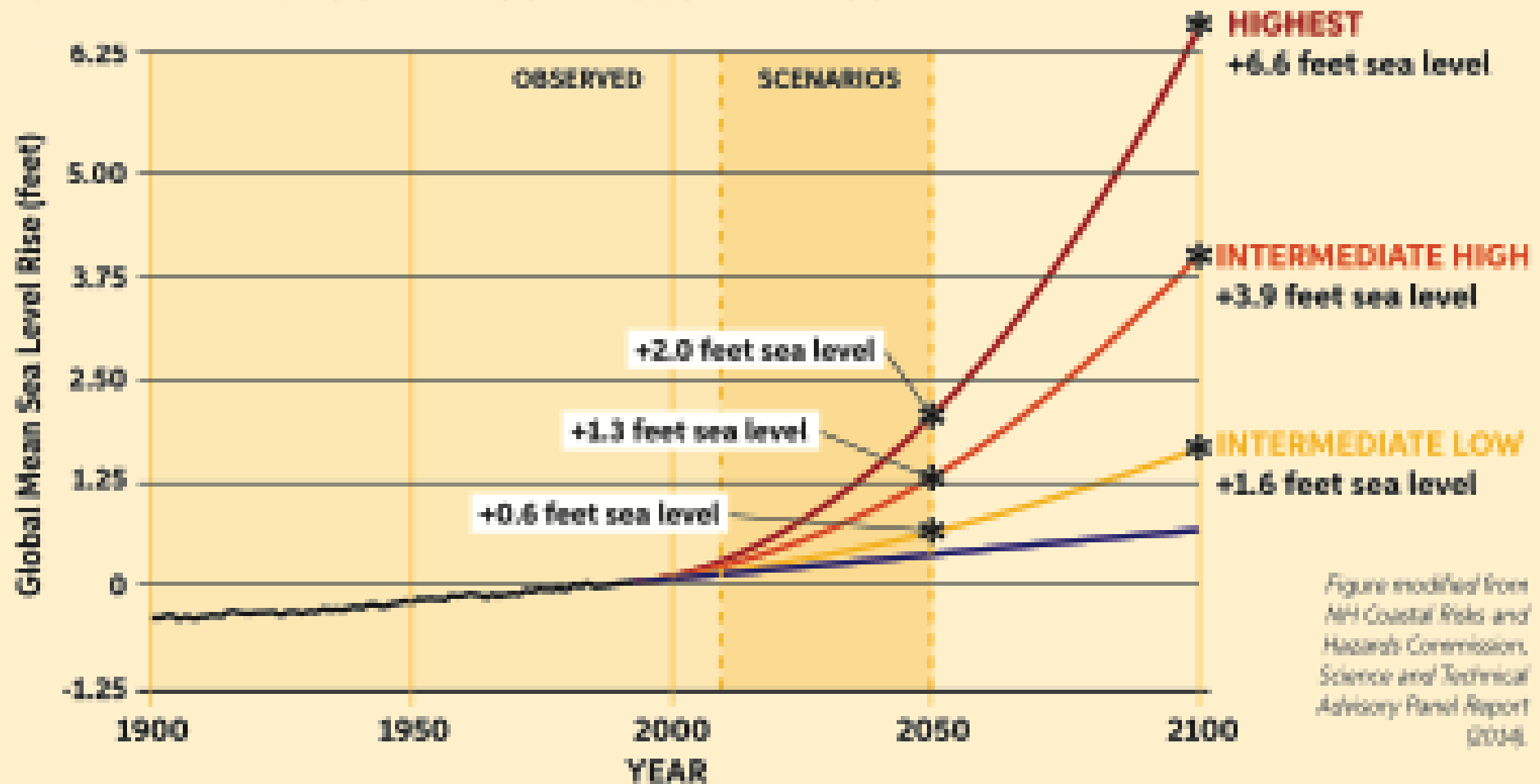
Stephen Gill (US NOAA)

Robert Kopp (Rutgers University)

<http://ClimateSolutionsNE.org>

Sea Level Rise, Storm Surges, and Extreme Precipitation in Coastal New Hampshire: Analysis of Past and Projected Trends

SEA-LEVEL RISE SCENARIOS AT 2050 AND 2100



- Produce narrative descriptions and MAPS of land cover
- Range of possible future conditions
- Reflect key informant perspectives & existing plans/visions
- Maps provide boundary conditions for process models

Backyard
Amenities



Community
Amenities

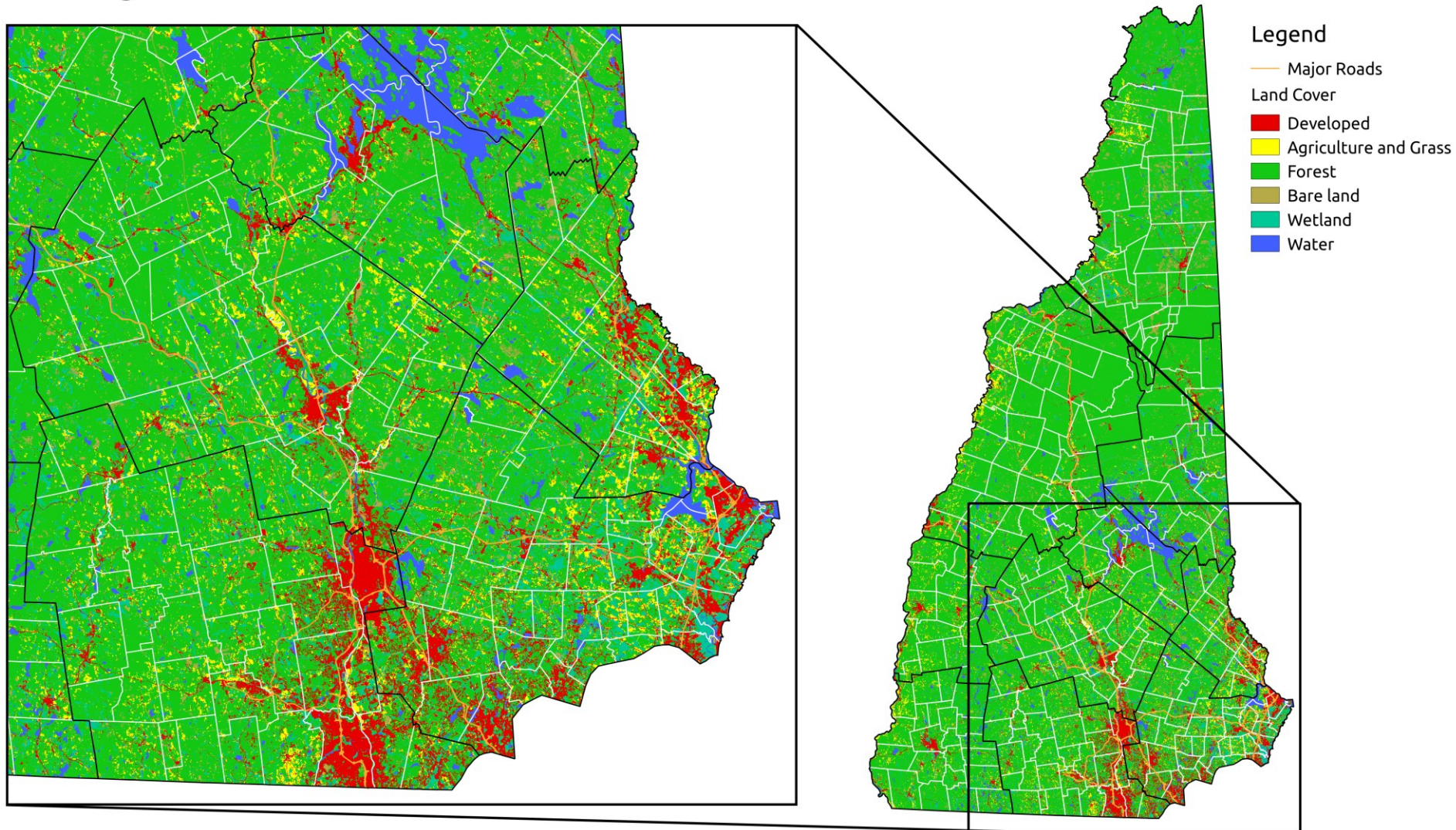


Community
Amenities with Ag



Backyard Amenities (Dispersed)

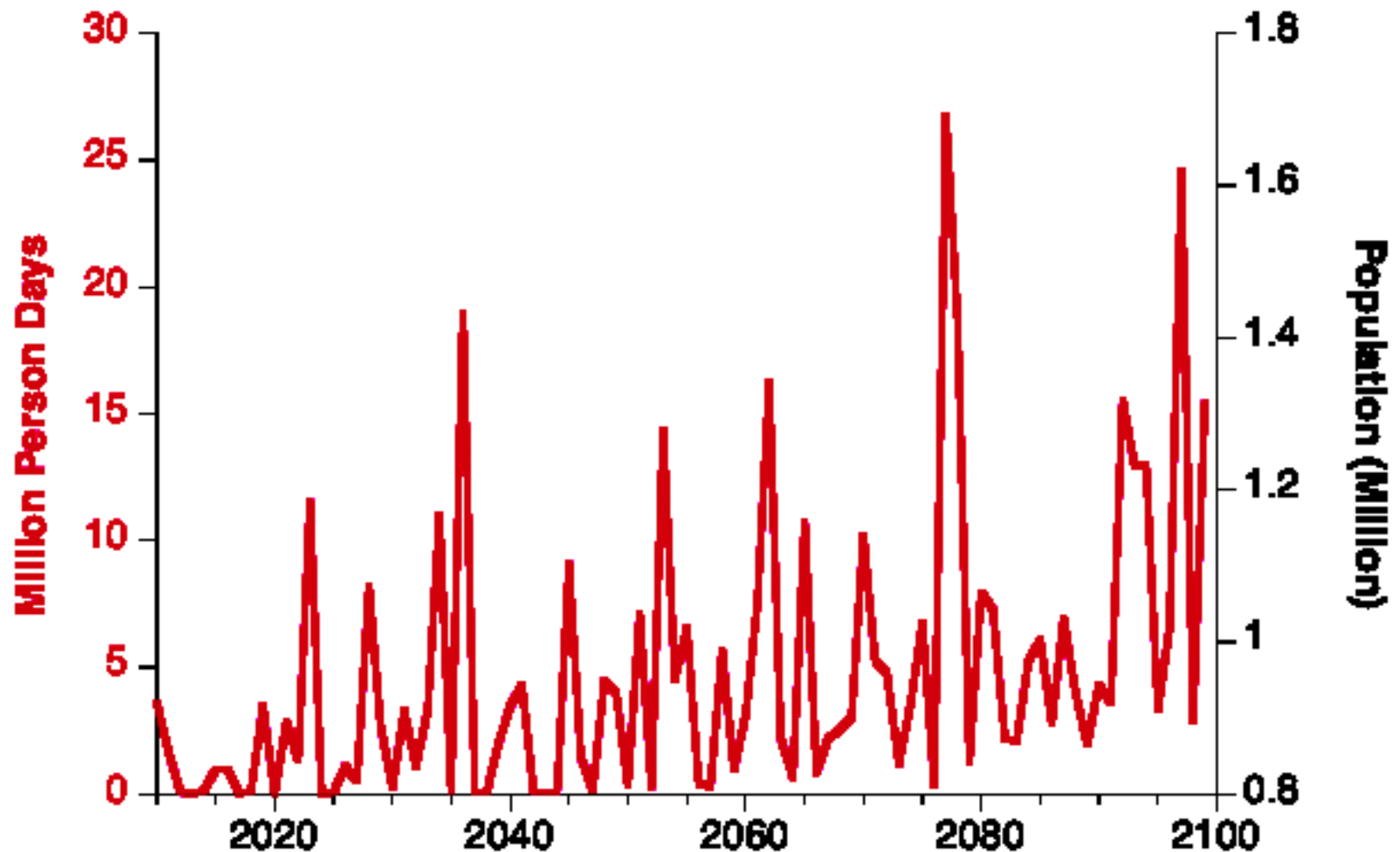
Backyard Amenities: 2010



Data Discovery Center: ddc.unh.edu

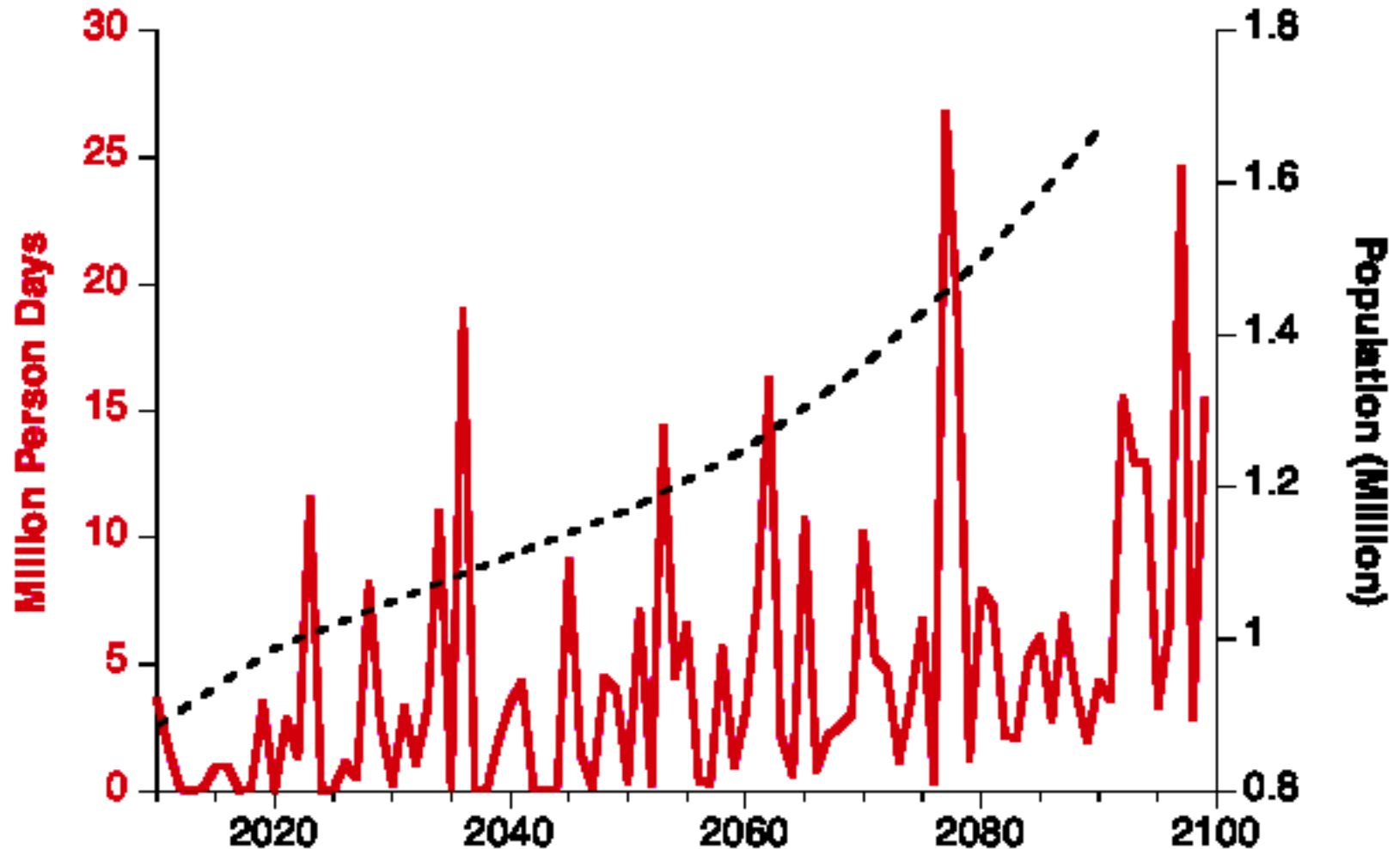
NH Merrimack Watershed (Backyard Amenities Land Cover; Hi Emissions)

MODELED Person Days of Surface Water Hydrologic Supply Shortfall



Modeled using coupled terrestrial (PnET) and gridded river network model (FrAMES)
Climate from GFDL CM2.1 driven with CMIP3 A1Fi emissions scenario
Population estimates from EPA ICLUS

Merrimack Watershed: MODELED Person Days of Surface Water Hydrologic Supply Shortfall



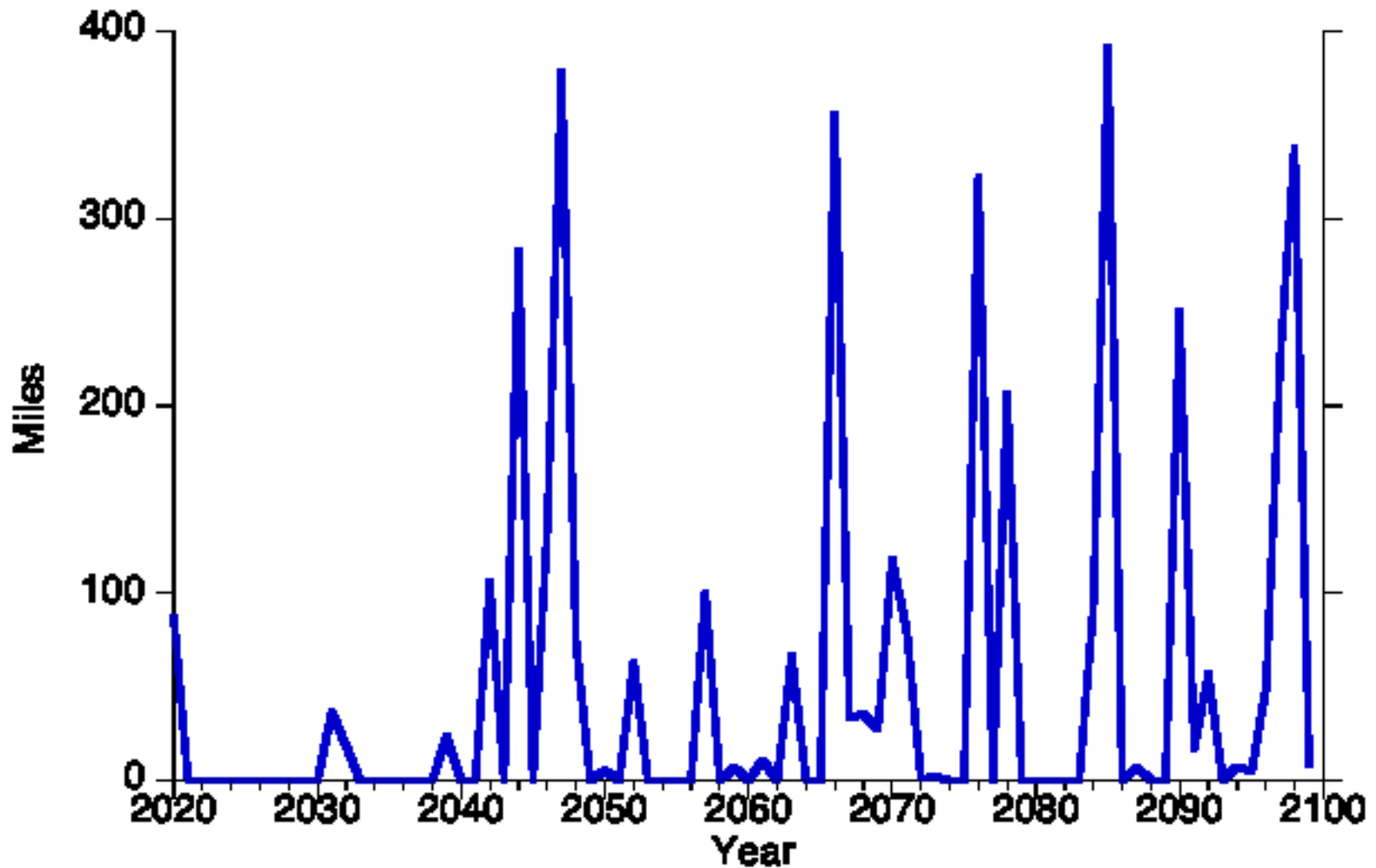
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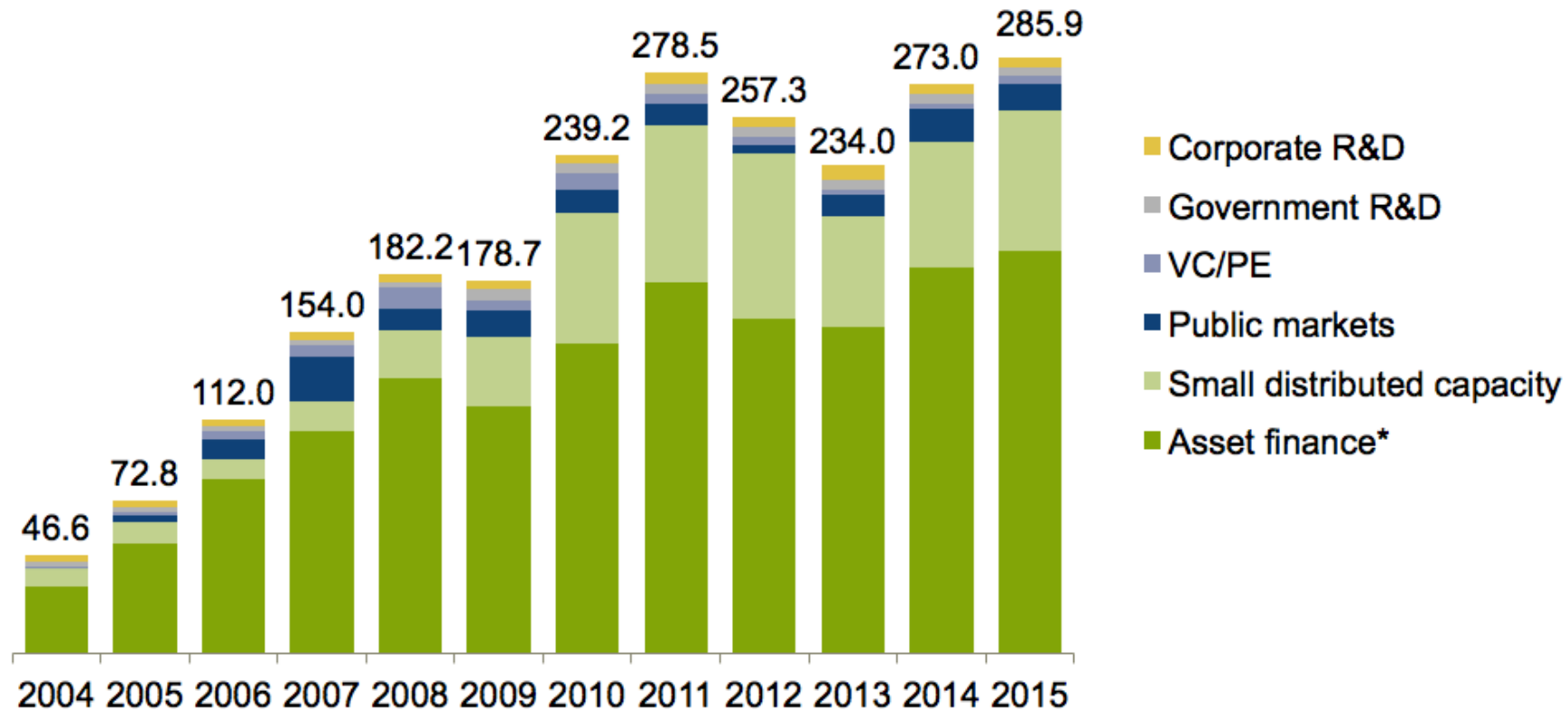
NH Merrimack Watershed (Backyard Amenities Land Cover; Hi Emissions)

Miles of river network exceeding the Olson 100-yr flood discharge



Modeled using coupled terrestrial (PnET) and gridded river network model (FrAMES)
Climate from GFDL CM2.1 driven with CMIP3 A1Fi emissions scenario

Annual Global Investment in Renewable Energy



Net Generating Capacity Added Globally in 2015

Renewable (without large hydro) 53%

Coal 17%

Gas 16%

Large hydro 9%

Nuclear 6%

